S. Hrg. 102-5 (Pt. 11)

NATIONAL ENERGY SECURITY ACT OF 1991

(Subtitle A of Title V)

HEARING

BEFORE THE

SUBCOMMITTEE ON
ENERGY RESEARCH AND DEVELOPMENT

OF THE

COMMITTEE ON
ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE

ONE HUNDRED SECOND CONGRESS

FIRST SESSION

ON

S. 341

TO REDUCE THE NATION'S DEPENDENCE ON IMPORTED OIL, TO PROVIDE FOR THE ENERGY SECURITY OF THE NATION AND FOR OTHER PURPOSES

MARCH 19, 1991

PART 11

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NATIONAL ENERGY SECURITY ACT OF 1991

(Subtitle A of Title V)

TUESDAY, MARCH 19, 1991

U.S. Senate,
Subcommittee on Energy Research and Development,
Committee on Energy and Natural Resources,
Washington, DC.

The subcommittee met, pursuant to notice, at 2:26 p.m., in room SD-317, Dirksen Building, Hon. Wendell H. Ford, presiding.

OPENING STATEMENT OF HON. WENDELL H. FORD, U.S. SENATOR FROM KENTUCKY

Senator Ford. Good afternoon, ladies and gentlemen. I am sorry we are late, but we may have more votes. You all will have to exercise a great deal of patience, and I will have to exercise a great deal of exercise going back and forth.

Today the Subcommittee on Energy Research and Development will receive testimony on the coal and coal technology provisions of S. 341. These provisions are contained in subtitle A of title V of S. 341. Coal now supplies 25 percent of the total energy requirements in the United States. Some 57 percent of the total U.S. electricity supply comes from coal.

There is a demonstrated reserve base of more than 475 billion short tons of coal in the United States. This is enough to meet our projected needs for almost 200 years. Coal is also inexpensive. These facts show that coal will continue to be a major part of the energy supply mix for years to come.

It simply will not make sense to stop using this homegrown resource. The recent war in the Persian Gulf should be enough to remind us of the need for products made in the USA. The key to the continued use of coal is to develop the technology to make it both clean and economical. As long as coal continues to be an inexpensive, clean source of energy, we will continue to use it.

Great progress is being made in technology to make coal cleaner. We are learning a lot about technologies that help deal with the environmental consequences of burning coal. We must continue to move these technologies forward. We must make these technologies available and cost competitive.

I am pleased to see that S. 341, the bill introduced by the distinguished chairman and ranking member of this committee, contains a number of provisions that will help meet those goals. Many of these provisions have already passed the Senate. I hope we will include additional coal provisions when the committee goes to mark up of S. 341.

I am disturbed, however, by the administration's lack of attention to coal in its national energy, strategy. The NES document contains many nice words, nice words of encouragement for coal. There are laudable goals in the NES document about maintaining competitiveness and encouraging exports.

But in the 165-page bill submitted by the administration, there is no mention of the word coal. The word coal does not even appear once—not once. Every other energy source is mentioned, oil, gas, nuclear, hydro, solar, geothermal, wind, biomass, and waste. But not coal. And I am getting unhappy, I want you to know that.

[Laughter.]

Senator FORD. And I am just working up to being unhappy, Mr. Gentile, I want you to know that.

[Laughter.]

Senator FORD. All types of potential alternative fuels are mentioned, methanol, ethanol, compressed natural gas, liquid petroleum gas, hydrogen, and electricity. But again, no mention of coal.

What about the synthetic liquid fuels made from coal? Surely these fuels are as competitive as many of the others at this point. To the administration, coal seems to have become nothing more than a poor, forgotten stepchild. It has become a stepchild who is briefly patted on the back but is given no allowance.

I hope that Mr. Gentile will tell us today why coal has been left out of the administration's energy bill. Perhaps he will tell us why the administration wants to eliminate the remainder of the Clean Coal program, the fifth solicitation. Boy, he is writing awful fast. Perhaps he will tell us how to reconcile the happy talk of the NES document with the realities I have just mentioned.

So we have a long afternoon ahead of us, and I intend to sit here until we get through.

[The prepared statements of Senators Wallop and Shelby, and the text of subtitle A of title V follow:]

Statement of
Senator Malcolm Wallop (R-WY)
Subcommittee on Energy Regulation and Conservation
Senate Committee on Energy and Natural Resources
March 19, 1991 (2:00 p.m.)

COAL AND COAL RESEARCH

Good afternoon. Today's hearing addresses one of the more difficult, but critical, energy issues facing those of us who are trying to formulate a National Energy Strategy: namely, how do we foster greater use of our nation's most abundant energy resource -- coal.

As a Senator from the largest coal producing State in our Nation, I know that our energy problems exist not because we have a shortage of energy resources but because we have failed to make them available to the American people. We prefer to rely on foreign energy supplies that are often produced with environmental impacts that would be considered unacceptable in the United States.

The Committee's hearings have produced an abundance of energy efficiency and renewable energy proposals. Some of them are good, others are not. However, there is a dearth of constructive proposals to promote the production and greater use of our nation's abundant oil, natural gas, hydro, coal, and nuclear resources. The legislation now before us proposes a number of actions to correct this situation.

As a nation, we have demonstrated our capability to develop and use all forms of energy in an environmentally appropriate manner. Apparently, our ability to do so is not enough for some extreme environmental advocates who seek an benign environment. In my view their position is irresponsible.

As policy makers, we are responsible for the long-term needs of our society in its broadest context. We must protect the environmental values that all Americans expect, but we also must provide for economic growth and opportunities for choice on which the American people rely for their livelihood.

The legislation before us, S. 341, includes a number of proposal that are intended to foster both the domestic and international use of coal in a more environmentally responsible manner. In order to accomplish this objective, the measure requires a restructuring of DOE's coal research programs to place greater emphasis on commercialization activities which reflect experience with the Clean Coal Technology program. The measure also contains initiatives to foster research and development on non-fuel uses of coal, and technologies for the use of coal in oil and water mixtures, such as in diesel locomotive engines.

On the international front, the measure contains initiatives to foster the export of coal and clean coal technologies. These initiatives include establishment of a Clean Coal Technology Export Coordinating Council to facilitate the expanded use of such technologies in lesser-developed countries.

If international concerns for global climate change should prove valid, it is essential that other countries which intend to rely on indigenous coal resources for their economic development do so in a manner that recognizes international environmental concerns. What contribution the United States may have made to any global climate change would be dwarfed by the anticipated increases in fossil fuel use by developing nations.

It is important to note that legislation to implement the President's proposed National Energy Strategy, S. 570, does not contain any provisions related to coal research, production and use, or with respect to the export of coal or clean coal technologies. The Administration does propose a number of administrative initiatives related to coal. However, it is my judgment that our final legislation must contain initiatives in the critical area of coal research and the fostering of export markets for clean coal technologies as well as energy efficiency and renewable energy technologies.

I therefore look forward to today's testimony as an indication of where we can reach agreement on initiatives in these critical areas.

Richard Shelby

MR. CHAIRMAN: I AM PLEASED TO BE A PART OF THIS HEARING TODAY AND WELCOME THE OPPORTUNITY TO RECEIVE TESTIMONY ON THE COAL AND COAL TECHNOLOGY PROVISIONS OF S. 341, THE NATIONAL ENERGY SECURITY ACT OF 1991.

THIS IS PERHAPS ONE OF THE MOST IMPORTANT PROVISIONS OF THE JOHNSTON/ WALLOP BILL. OUR NATION IS SCRAMBLING TO FIND NEW SOURCES OF OIL, AS OUR DOMESTIC SUPPLY IS ON A STEADY, DOWNWARD SPIRAL. HOWEVER, COAL REMAINS IN ABUNDANCE.

LAST YEAR, DOMESTIC COAL PRODUCTION SKYROCKETED TO A RECORD LEVEL OF A BILLION TONS. IN 1989, THE NATION RELIED ON COAL TO MEET NEARLY 23% OF OUR TOTAL ENERGY NEEDS AND 57% OF OUR ELECTRICAL SUPPLY.

NOT ONLY HAS DOMESTIC DEMAND FOR COAL INCREASED, BUT EXPORT DEMAND HAS RISEN BY AS MUCH AS 8% OVER THE LAST FOUR YEARS. ENVIRONMENTAL SAFEGUARDS IN COUNTRIES LIKE GERMANY ARE OPENING NEW MARKETS FOR U.S. COAL. ALSO, BRITAIN IS IN THE PROCESS OF PRIVITIZING THE ELECTRIC UTILITY INDUSTRY, WHICH FOR THE FIRST TIME, WOULD OPEN UP THAT MARKET TO OUTSIDE COMPETITION.

AN ENERGY POLICY MUST HAVE BUILDING BLOCKS AND COAL UNMISTAKABLY MUST BE ONE OF THEM. THE FUTURE FOR THE COAL INDUSTRY IS VERY PROMISING, BOTH AS AN ABUNDANT SOURCE OF ENERGY AND A MAJOR EXPORT, ENHANCING U.S. COMPETITIVENESS IN INTERNATIONAL MARKETS. WE CANNOT NEGLECT TO NURTURE THE RESEARCH AND DEVELOPMENT OF NEW TECHNOLOGIES IN THIS INDUSTRY.

WITH CONTINUED TECHNOLOGICAL ADVANCEMENTS TO MAKE COAL CLEANER, WE ARE RAPIDLY APPROACHING THE DAY WHEN COAL CAN NO LONGER BE CONSIDERED A MAJOR CONTRIBUTOR TO THE WORLD'S ENVIRONMENTAL PROBLEMS. ALREADY, LOW SULFUR COAL HAS HELPED THE ELECTRICITY INDUSTRY COMBAT ITS EMISSIONS PROBLEMS. TECHNOLOGIES SUCH AS COAL GASIFICATION SHOULD BE ON THE MARKET WITHIN THE NEXT SEVEN OR EIGHT YEARS.

I AM PLEASED THAT S. 341 RECOGNIZES THE VITAL IMPORTANCE OF DEVELOPING COAL AS AN EFFECTIVE, CLEAN, ABUNDANT AND ECONOMICALLY SOUND SOURCE OF ENERGY.

WHEN THE ADMINISTRATION PRESENTED THE FULL COMMITTEE WITH ITS EXECUTIVE SUMMARY OF THEIR NATIONAL ENERGY STRATEGY, I WAS DELIGHTED THAT THEY SEEMINGLY RECOGNIZED THE IMPORTANCE OF COAL. HOWEVER, UPON CLOSER EXAMINATION OF THE SUBSEQUENT LEGISLATION, IT APPEARS THAT THE ADMINISTRATION HAS DONE JUST THAT--RECOGNIZED. I HAVE REVIEWED THE CHARTS PREPARED BY THE COMMITTEE STAFF COMPARING TITLE V OF S. 341 WITH THE NATIONAL ENERGY STRATEGY (NES) AND FOR JUST ABOUT EVERY PROVISION CONCERNING COAL IN S. 341, THERE IS NO COMPARABLE PROVISION IN THE NES.

PERHAPS THE MOST DISTURBING THING ABOUT THIS ISSUE IS THE FACT THAT THE ADMINISTRATION HAS NOT REQUESTED FUNDING IN ITS FY 92 BUDGET REQUEST FOR ROUND 5 OF THE CLEAN COAL TECHNOLOGY PROGRAM. THIS APPEARS TO BE A CASE OF NOT "PUTTING YOUR MONEY WHERE YOUR MOUTH IS."

I LOOK FORWARD TO HEARING FROM OUR WITNESSES AND BELIEVE THAT THEY WILL SHED FURTHER LIGHT THIS ISSUE. I AM PARTICULARLY INTERESTED IN HEARING THE ADMINISTRATION'S POINT OF VIEW.

II

102D CONGRESS
1ST SESSION

S. 341

To reduce the Nation's dependence on imported oil, to provide for the energy security of the Nation and for other purposes.

IN THE SENATE OF THE UNITED STATES

FEBRUARY 5 (legislative day, JANUARY 3), 1991

Mr. JOHNSTON (for himself and Mr. WALLOP) introduced the following bill; which was read twice and referred to the Committee on Energy and Natural Resources

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A BILL

To reduce the Nation's dependence on imported oil, to provide for the energy security of the Nation and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be referred to as the "National Energy Security Act of 1991".

* * * * * * *

TITLE V—COAL, COAL TECHNOLOGY AND ELECTRICITY

Subtitle A—Coal and Coal Technology

SEC. 5001. COAL RESEARCH, DEVELOPMENT, AND DEMONSTRATION PROGRAM.—(a) ESTABLISHMENT.—The Secretary, in consultation with the National Coal Council and other representatives of the public as the Secretary deems necessary, shall, in accordance with the Federal Nonnuclear Energy Research and Development Policy Act of 1974 (42 U.S.C. 5901–5920), conduct a research, development, and demonstration program within the Department of Energy for advanced coal-based technologies with the goal and objective of achieving the control of sulfur oxides and oxides of nitrogen at levels of proficiency greater than currently available commercial technology. The coal technology development program shall also be designed to assure the timely development of cost-effective technologies or energy production processes or systems utilizing coal which achieve greater efficiency in the conversion of coal to useful energy when compared to currently available commercial technology for the use of coal and the control of emissions from the combustion of coal. Such program shall be designed to assure the availability for commercial use of such technologies by the year 2010.

(b) REPORT.—Within two hundred and forty days after the date of enactment of this Act the Secretary shall transmit to the United States House of Representatives and the Committee on Energy and Natural Resources of the United States Senate a report which shall include—

(1) a detailed description of ongoing research and development activities regarding advanced coal-based technologies undertaken by the Department of Energy, other Federal or State government departments or agencies and, to the extent such information is publicly available, other public or private organizations in the United States and other countries;

(2) a listing and analysis of current Federal and State government regulatory and financial incentives that could further the goals of the program established by this section;

(3) recommendations, if any, regarding additional cost-sharing demonstrations conducted pursuant to the Clean Coal Program established by Public Law 98-473, that could assure that the goals of the program established by this section are achieved; and

(4) a detailed plan for conducting the research, development, and demonstration program to achieve the goals and objectives of subsection (a) of this section, which plan shall include a description of—

(i) the program elements and management structure to be utilized; and

(ii) the technical milestones to be achieved with respect to each of the advanced coal-based technologies included in the plan.

(c) ANNUAL REPORT.—Within twelve months after submittal of the report described in subsection (b) of this section, and every twelve months thereafter for a period of five years, the Secretary shall submit to the Congress a report that provides a detailed description of the status of development of the advanced coal-based technologies and the research, development, and demonstration activities undertaken to carry out the program required by this section.

(d) DEFINITION.—As used in this section, the term "advanced coal-based technologies" means, but is not limited to, the following—

(1) advanced integrated gasification combined cycle;

(2) pressurized fluidized bed combustion technology capable of achieving higher thermal conversion effi-

ciency than can be achieved through ongoing demonstration projects;

(3) direct and indirect coal-fired turbines;

(4) coal refining processes capable of efficiently producing or utilizing the energy contained in coal and also utilizing the byproducts thereof;

(5) magnetohydrodynamics;

(6) molten carbonate and solid oxide fuel cells;

(7) coal liquefaction processes; and

(8) other coal-based technologies or processes or systems that are capable of achieving thermal conversion efficiencies equal to or greater than 50 per centum.

SEC. 5002. NON-FUEL USE OF COAL.—(a) PLAN.—Not later than one hundred and twenty days after the date of the enactment of this Act, the Secretary shall submit to Congress a plan for research, development, and demonstration with respect to technologies for non-fuel use of coal, including—

(1) production of coke and other carbon products derived from coal;

(2) production of coal-derived, carbon-based chemical intermediates that are precursors of value-added chemicals and polymers;

(3) production of chemicals from coal-derived synthesis gas;

(4) coal treatment processes, including methodologies such as solvent-extraction techniques that produce low ash, low sulfur, coal-based chemical feedstocks; and

(5) waste utilization, including recovery, processing, and marketing of products derived from sulfur, carbon dioxide, nitrogen, and ash from coal.

(b) JOINT VENTURES.—As part of the plan under subsection (a), the Secretary may propose specific joint ventures to accelerate the development and commercialization of technologies for non-fuel uses of coal.

(c) PLAN CONTENTS.—The plan under subsection (a) shall address and evaluate—

(1) the known and potential products and processes for the use of coal for products in the chemical, utility, fuel, and carbon-based materials industries;

(2) the costs, benefits and economic feasibility of using coal products in the chemical and materials industries, including value-added chemicals, carbon-based products, coke, and waste derived from coal;

(3) the economics of co-production of products from coal in conjunction with production of electric power, thermal energy, and fuel;

(4) the economics of coal utilization in comparison with other feedstocks that might be used for the same purposes;

(5) the steps that can be taken by the public and private sectors to bring about commercialization of research results produced by the research program recommended; and

(6) the past development, current status, and future potential of coal products and processes associated with non-fuel use of coal.

(d) RESEARCH AND DEVELOPMENT.—The Secretary shall conduct a program of research and development under the plan under subsection (a).

(e) FUNDING.—The Secretary may provide financial assistance for a research project under the plan using funds authorized by section 5007(b) to the extent the Secretary finds that such project—

(1) furthers achievement of the goals and purposes of this Act;

(2) offers promise for commercial application; and

(3) has a reasonable prospect of support in at least 50 per centum of its direct costs from non-Federal funds.

(f) CONSULTATION.—In preparing the plan and carrying out research under this section, including evaluating the technical progress, feasibility, and most effective means for utilizing the results of research, the Secretary shall consult with the private sector.

SEC. 5003. COAL EXPORTS.—(a) PLAN.—Within one hundred and eighty days after the date of enactment of this section, the Secretary, in consultation with the Secretary of Commerce, the Secretary of State, and the United States Trade Representative, shall submit to the United States House of Representatives and the Committee on Energy and Natural Resources of the United States Senate a plan for expanding the export of United States coal.

(b) PLAN CONTENTS.—Such plan shall include—

(1) identification of the location, size, and projected growth in potential foreign markets for coal produced in the United States;

(2) identification by country of the existence of barriers to United States coal exports, including foreign coal production and utilization subsidies, tax treatment, labor practices, tariffs, quotas, and other nontariff barriers;

(3) recommendations and an action plan for addressing any such barriers;

(4) an evaluation of existing United States infrastructure, and any new infrastructure requirements within the United States to support an expansion of

United States coal exports, including ports, vessels, rail lines, and any other supporting infrastructure; and

(5) identification of opportunities for blending United States coal exports with coal indigenous to the importing country to enhance energy efficiency and environmental performance.

SEC. 5004. CLEAN COAL TECHNOLOGY EXPORT COORDINATING COUNCIL.—(a) ESTABLISHMENT.—There shall be established a Clean Coal Technology Export Coordinating Council (hereinafter "Council") which shall seek to facilitate and expand the export and use of clean coal technologies. The Council shall place a priority on the export and use of clean coal technologies in lesser developed countries.

(b) MEMBERSHIP.—The Council shall consist of the Secretary, who shall serve as its chairperson, the Secretary of Commerce, the Secretary of State (including a designee from the Agency for International Development and the Trade and Development Program), the Administrator of the Environmental Protection Agency, the President and Chairman of the Export-Import Bank, and the President and Chief Executive Officer of the Overseas Private Investment Corporation.

(c) CONSULTATION.—In undertaking its responsibilities, the Council shall consult with representatives from the United States coal industry, the electric utility industry, manufacturers of equipment utilizing clean coal technology, members of organizations formed to further the goals of environmental protection or to promote the development and use of clean coal technologies, and other appropriate interested members of the public.

(d) DUTIES.—In furthering the purposes of this section, the Council shall—

(1) facilitate the establishment of technical training for local users and international development personnel;

(2) cause to be established within existing departments and agencies financial assistance programs to support pre-feasibility and feasibility studies for projects that will utilize clean coal technologies and loan guarantee programs designed to facilitate access to capital and credit in order to finance such clean coal technology projects;

(3) develop and execute programs, including the establishment of financial incentives, to encourage and support private sector efforts to export clean coal technologies; and

(4) review ongoing clean coal technology projects and review and approve planned clean coal technology projects, which are sponsored abroad by any Federal Government agency to determine whether such

projects are consistent with the overall goals and objectives of this section.

(e) DATA AND INFORMATION.—The Council shall be responsible for the development of a comprehensive data base and information dissemination system relating to the availability of clean coal technologies and an on-going assessment of the potential need for such technologies particularly in lesser developed countries. The Council shall provide a country-by-country assessment of the potential for the use of clean coal technology. The Council shall make such information available to industry, Federal and international financing organizations, nongovernmental organizations, officials in countries where such clean coal technologies might be utilized, and such others as the Council deems necessary. In developing this data base and on-going assessment, the Council shall consult with the Committee on Renewable Energy Commerce and Trade.

(f) REPORT.—Within one hundred and eighty days after the Secretary submits the report to the Congress as required by section 409 of Public Law 101–549, the Council, in consultation with those persons referenced in subsection (c) of this section, shall provide to the United States House of Representatives and the Committee on Energy and Natural Resources of the United States Senate a plan which details actions to be taken in order to address those recommendations and findings made in the report submitted pursuant to section 409 of Public Law 101–549. As a part of the plan required by this subsection, the Secretary shall specifically address the adequacy of financial assistance available from Federal departments and agencies and international financing organizations to aid in the financing of pre-feasibility and feasibility studies and projects that would utilize a clean coal technology in lesser developed countries.

SEC. 5005. COAL FUEL MIXTURES.—Within one year following the date of enactment of this Act, the Secretary shall report to the Committee on Energy and Natural Resources in the United States Senate and the United States House of Representatives on the status of technologies for combining coal with other materials, such as oil or water fuel mixtures. The report shall include—

(1) a technical and economic feasibility assessment of such technologies;

(2) projected developments in such technologies;

(3) an assessment of the market potential of such technologies, including the potential to displace imported crude oil and refined petroleum products;

(4) identification of barriers to commercialization technologies; and

(5) recommendations for addressing barriers to commercialization.

SEC. 5006. COAL FIRED LOCOMOTIVES.—The Secretary shall conduct a research, development, and demonstration program for utilizing "ultra-clean coal-water slurry" in diesel locomotive engines. The program shall address, but not be limited to, the following:

(1) required engine retrofit technology;

(2) coal-fuel production technology;

(3) emission control requirements;

(4) fuel delivery and storage systems requirements; and

(5) other infrastructure required to support commercial deployment.

SEC. 5007. AUTHORIZATIONS.—(a) There is authorized to be appropriated such sums as are necessary for each of fiscal years 1992, 1993, and 1994 for purposes of implementing the program pursuant to section 5001.

(b) There is authorized to be appropriated to carry out section 5002 a total of $20,000,000 for fiscal years 1992 through 1994.

(c) There is authorized to be appropriated such sums as may be necessary for each of the fiscal years 1992, 1993, and 1994 to carry out the purposes of section 5004.

SEC. 5008. ESTABLISHMENT OF DATA BASE AND STUDY OF COAL TRANSPORTATION RATES. (a) ESTABLISHMENT OF DATA BASE.—The Secretary is authorized and directed to establish a data base containing, to the maximum extent practicable, all transportation rates for rail, pipeline, truck, conveyor belt, barge, and other modes of transporting domestic coal during the period January 1, 1988, through December 31, 1997. The confidentiality of contract rates shall be preserved and public access to the data base shall be provided under appropriate terms and conditions that protect the confidentiality of specific contract rates.

(b) STUDY OF COAL TRANSPORTATION RATES.—The Secretary shall study the rates and distribution patterns of domestic coal to determine the impact of the Clean Air Act Amendments of 1990 and other Federal policies on such rates and distribution patterns. The study shall consider, among other factors—

(1) the extent to which coal transportation rate increases occur as a result of the enactment of the Clean Air Act Amendments of 1990 and other Federal policies;

(2) any increases or decreases in the revenue to variable cost ratios of railroad coal transportation rates during the period of the study and the percentage of the delivered price of coal to electric generating facilities that is attributable to coal transportation rates during this period;

(3) any changes in the distribution patterns of coal among the various regions of the Nation during the study period; and

(4) any electricity rate increases or decreases in the various regions of the Nation during the period of study that are attributable to coal transportation costs.

(c) REPORTS TO CONGRESS.—The Secretary shall submit an interim report to Congress on January 1, 1993, and a final report to Congress, together with any recommendations, on January 1, 1995. The Secretary shall submit an additional report to Congress, with recommendations, on January 1, 1998. The Administrator of the Energy Information Administration and the Chairmen of the Federal Energy Regulatory Commission and the Interstate Commerce Commission shall cooperate fully with the Secretary in the development of the data base and studies authorized by this section.

* * * * * * *

STATEMENT OF HON. CONRAD BURNS, U.S. SENATOR FROM MONTANA

Senator **Ford**. Senator Burns, do you have a statement you would like to make?

Senator **Burns**. Not after that one, Mr. Chairman.

[Laughter.]

Senator **Burns**. Mr. Chairman, I have a statement I would like to submit to the record, but I know of your energies and your dedication to the main energy resource and one of the main resources of Kentucky. We too, in Montana have 53 percent of the bituminous coal there is in this country, and awful close to the surface and accessible. And I, too, was a little disappointed that coal was not given more room and maybe paid the respect that other fuels are paid in the administration.

But that also gives us an opportunity to open the dialogue and maybe address it in the ways that it should be. So I would ask unanimous consent that my statement be entered in the record.

Senator **Ford**. Without objection, it will be included in the record as if given.

Senator **Burns**. I also have a statement from the Carbon Fuels Corporation regarding coal, and I would ask unanimous consent that it be submitted for the record. And I have got a lot of questions.

Senator **Ford**. Senator Burns, we have a statement from Carbon Fuels Corp. and the Association of American Railroads, and I ask unanimous consent that they be included in the record. Both of ours are the same, I think.

Senator **Burns**. Just so it gets in there. Your energies on this committee with regard to coal has been up front ever since I have been a member of this committee. I am looking forward to the testimony of our guest today. So thank you very much.

[The prepared statement of Senator Burns and the information referred to follow:]

COAL AND COAL RESEARCH
A STATEMENT BY
SENATOR CONRAD BURNS (R-MT)
MARCH 19, 1991

I appreciate the Chairman's holding this important hearing in conjunction with a national energy strategy. The United States has tremendous reserves of coal, virtually an OPEC of coal, and Montana is the Saudi Arabia of coal. Coal can and should be a major part of the solution to this country's foreign energy dependence.

Last week I introduced legislation designed to reduce America's dangerous energy dependence. I also intend to introduce legislation soon to highlight the refining of coal. In this manner we can begin to supplement our foreign oil dependence with coal-derived transportation fuels and clean boiler fuels that will make scrubbing obsolete.

It is my firm belief that coal must be given the same respect as once plentiful oil reserves. We used technology to win the war in the Middle East; it must be used now to break the bonds of dependence on imported oil.

We can and must meet our energy needs by applying American technology such as refining and MHD to Americas's most abundant fuel resource: coal.

As Senator's from coal states know, coal has traditionally been thought of as useable only in its raw form -- deliver a ton of coal to a utility and burn it. Coal is our only major fuel source that is not refined -- oil is refined, uranium is refined, natural gas is refined, but not coal. In coal the battle is between high sulphur coal and low sulphur coal. Consumers don't care whether a gallon of gasoline is from high sulphur oil or low sulphur oil, because gasoline is a refined product -- gasoline. It should be the same for coal.

Clean coal technologies, a majority of which have been funded by DOE under our Clean Coal Program have focused on cleaning up the air **AFTER** the coal has been burned rather than producing clean, value-added fuels -- including transportation fuels -- from coal. We simply cannot go on looking for ways to burn raw coal. We must look for ways to refine this valuable resource to produce clean, value-added fuels compatible with our petroleum-based distribution and marketing systems.

MHD research has been moving ahead but it has reached a critical phase. Now is the time to move ahead and retrofit an actual power plant. We are at that point and should move ahead.

In a coal refining process, approximately 2 tons of coal are required to make about 1 ton of boiler fuel **AND** about 1 ton of value-added co-products. This results in double the demand for raw domestic coal. Since the coal refining process can be applied to a wide range of coal feedstocks, mine mouth plants can be located in all coal producing states, not only increasing mining jobs, but also employing operators for the refining facility and creating new jobs for support and spin-off industries.

Application of coal refining technology will not only permit cost-effective reduction of SO2, NOX, and air toxic emissions but will encourage economic development in regions where refining facilities are located. The refining facilities themselves are also environmentally benign, producing no envirnmentally incompatible waste streams. The only effluent is clean flue gas.

Coal refining provides a unique opportunity to satisfy four national goals:

(A) reduce dependence on foreign oil by the efficient, economical utilization of an abundant domestic resource;
(B) improve our balance of trade by creating a new export industry;
(C) continue the progress made in cleaning up the air by resolving the conflict between coal and overall environmental protection; and
(D) meet the challenge of economical power generation at a reduced cost and with increased productivity.

We must move ahead and establish a coal refining technology program in DOE as quickly as possible in order to free us from our dependence on foreign energy.

Thank you.

TESTIMONY BY CARBON FUELS CORPORATION REGARDING A NATIONAL ENERGY POLICY

Mr. Chairman and members of the Senate Energy and Natural Resources Committee, we are pleased to be able to submit testimony regarding the National Energy Security Act of 1991, and specifically Title V - Coal, Coal Technology, and Electricity.

When Senator Wallop and Senator Johnston introduced this legislation, Senator Johnston explained that only a "Made in America" energy policy could free us from a crippling dependence on imported oil. When the bill was introduced on February 5, this country and its allies were at war, in part because much of the world's economy relies upon the Persian Gulf for supplies of oil. Senator Johnston expressed concern that:

> "We are asking young men and women to risk injury and death in the Persian Gulf to prevent energy blackmail. We have no right to ask that kind of sacrifice without doing the absolute best we can to put our domestic energy policy in order."

Our absolute best can be no less than the utilization of existing technology to turn this nation's vast array of resources to its best energy advantage in an economical, efficient, environmentally acceptable manner.

In a Lincoln Day speech in Cheyenne, Wyoming on February 11, 1991, Admiral Watkins, the Secretary of Energy, indicated that one of the reasons we were winning the war was the "Made in America" technology. He indicated that there had been many detractors who did not believe in the SDI program. Nevertheless, it was this technology which enabled patriot missiles to knock scuds out of the air, smart bombs and laser bombs to hit only targeted buildings, to use satellite directed targeting systems to fire our tank cannons in a battle where the combatants never saw one another. Likewise, technology must be the instrument which enables us to break the bonds of dependence on imported oil, allowing us to meet our energy needs by use of domestic resources.

As Senator Johnston stated so succinctly,

> "An effective energy policy requires long-term planning and investment by a very large number of private entrepreneurs. If the price of energy fluctuates as wildly as it has in the last twenty years, this planning is virtually impossible to carry out. The needed long term investments will not be made."

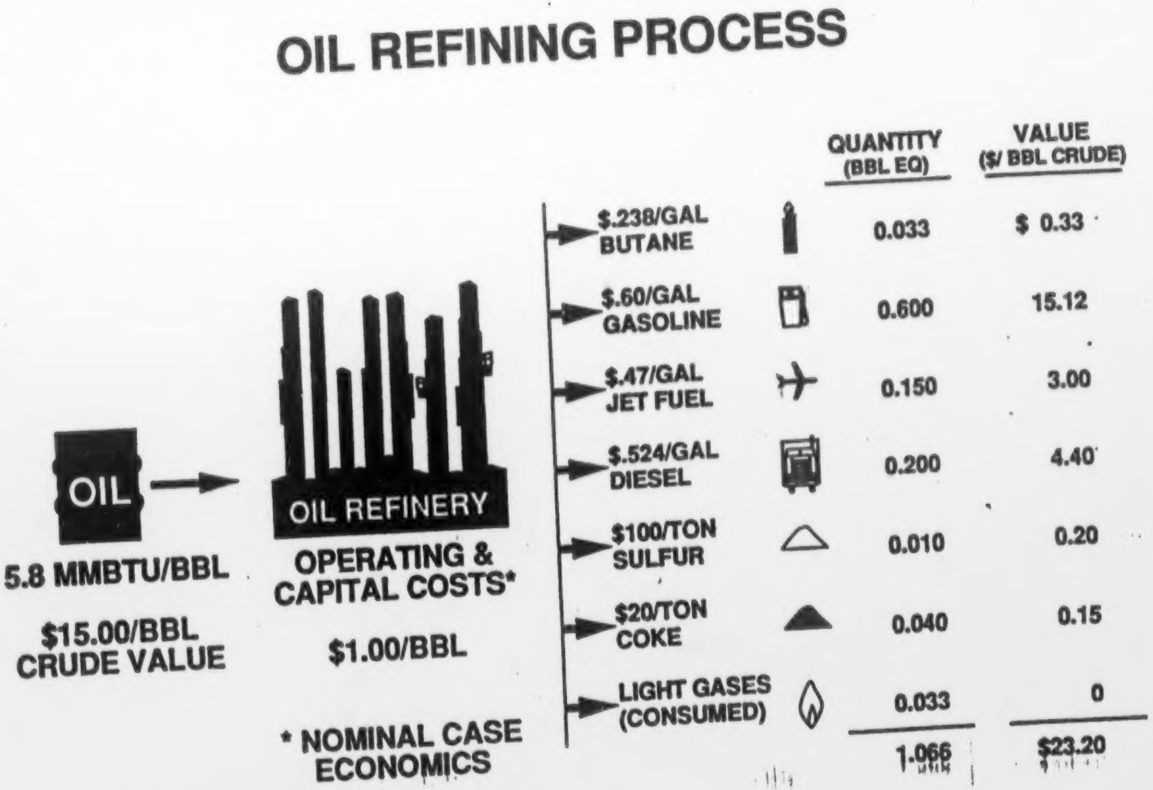
It has been widely believed that when oil prices reached $30 to $35 per barrel, the technology necessary for an alternative energy industry (i.e., oil shale, coal liquefaction, synfuels, and the like) would automatically be commercialized. However, a mere rise in oil prices does not engender enough confidence by industry to invest in the capital intensive facilities typically required for alternative fuel technologies. The fear is that if this capital were invested, OPEC would, as it has in the past, reduce oil prices below the point at which products from these technologies could compete. This is exactly what happened in the mid-1980s when Saudi Arabia overproduced and drove oil prices down to the $13 to $14 a barrel range, eliminating U.S. exportation, bankrupting drilling operations, and shutting down domestic production, causing economic recession and, ultimately, increasing dependence on foreign energy sources - specifically oil.

Senator Wallop, in his introductory remarks, said that our energy problems exist not because we have a shortage of resources but because we have failed to make those resources available to the American people. He reminded us that we have a choice:

> "we can act to assure our well-being, or we can instead do nothing and consign our future and our treasure to the good will of foreign producers...producers who have already demonstrated they have their interests, not ours, in mind."

The answer is to use existing technology to refine coal by thermal hydrocracking of the complex hydrocarbons in the raw coal to produce char (coke), liquid fuels, and chemical feedstocks. We must refine our valuable coal resource to produce clean, value-added products that mesh with our petroleum dominated delivery and distribution infrastructures. Coal-derived fuels, feedstocks, and other refined products must be the cornerstone of our independent energy plan.

The coal refining process, like petroleum refining, can produce a fairly broad range of hydrocarbon products. Product quality and quantity can be varied, by adjusting process parameters, to meet changing markets and to accommodate a variety of coal or lignite feedstocks. Since coal has a smaller ratio of hydrogen to carbon (1:1) than crude oil (2:1), the potential slate of coal-derived value-added co-products is somewhat different than the petroleum-derived slate. However, the raw coal feedstock is much less expensive than crude oil so the value-added factor (i.e., price of refined products divided by the sum of the cost of raw materials plus processing costs (capital and operating)) for a coal refining facility is much greater than that for an oil refinery. See Figures I, II and III. The economics of coal refining, particularly the Charfuel® hydrocracking process, have been developed and verified by Morrison-Knudsen Engineers; Ford, Bacon & Davis; Stone & Webster Engineering Corporation; W.R. Grace & Co., and Kidder, Peabody & Co. Technical demonstrations and data correlations by Western Research Institute have confirmed the work of companies like Cities Service, Rockwell, Amoco, and others who have been developing coal refining technologies for almost fifteen years.



OIL REFINING PROCESS

	QUANTITY (BBL EQ)	VALUE ($/ BBL CRUDE)
$.238/GAL BUTANE	0.033	$ 0.33
$.60/GAL GASOLINE	0.600	15.12
$.47/GAL JET FUEL	0.150	3.00
$.524/GAL DIESEL	0.200	4.40
$100/TON SULFUR	0.010	0.20
$20/TON COKE	0.040	0.15
LIGHT GASES (CONSUMED)	0.033	0
	1.066	$23.20

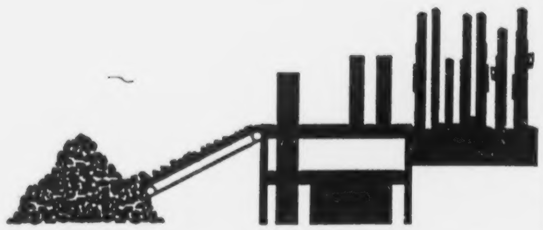
OIL
5.8 MMBTU/BBL
$15.00/BBL CRUDE VALUE
OIL REFINERY
OPERATING & CAPITAL COSTS*
$1.00/BBL
* NOMINAL CASE ECONOMICS

Note: Prices are for $15/BBL, Arabian Light from Octane Week, Nov. 21, 1988

FIGURE I

FIGURE II

CHARFUEL® REFINING PROCESS



POWDER RIVER BASIN COAL

16 MMBTU/TON

$7.00/TON

CHARFUEL® PROCESS

OPERATING & CAPITAL COSTS*

$17.00/TON

* ULTRA-CONSERVATIVE CASE ECONOMICS

		QUANTITY (TONS)	VALUE ($/ TON)
$1.15/GAL BTX	△	.0248	$ 7.98
$1.20/GAL NAPHTHA	▮	.0190	7.30
$0.60/GAL METHANOL	▯	.0157	2.86
$1.00/GAL MTBE	▯	.0057	1.85
$80.00/TON AMMONIA	░	.0043	0.34
$100.00/TON SULFUR	△	.0026	0.26
$2.00/MMBTU (DEL) CHARFUEL® FLUIDIC FUEL	▤	.4200	21.98
$1.25/MSCF CO2 (EOR)	▒	.2920	3.67
CHAR & LIGHT GASES		.0890	0 } CONSUMED
WATER		.2490	0 } CONSUMED
		1.1220*	$46.24

* INCLUDES OXYGEN CONSUMED IN PROCESS

Note: Prices from Chemical Marketing Reporter, Nov. 28, 1988

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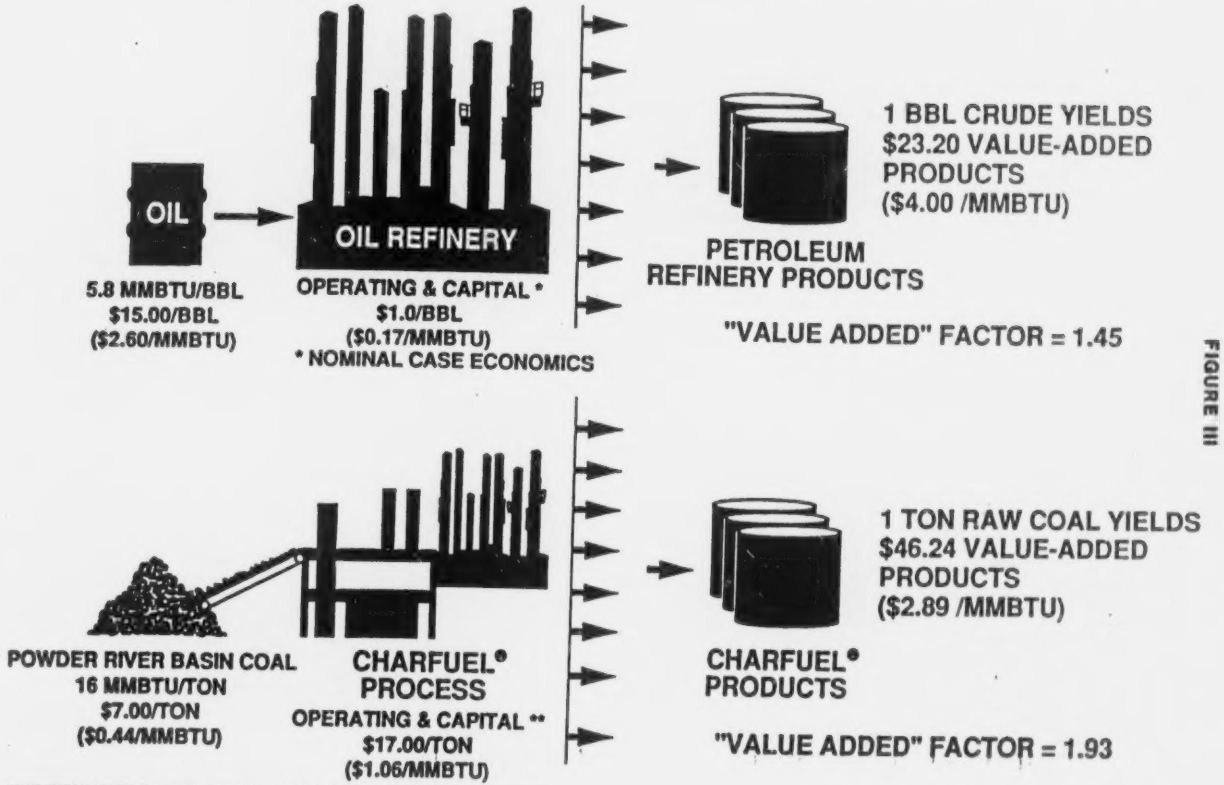
FIGURE III

ECONOMICS OF REFINING PROCESSES



5.8 MMBTU/BBL
$15.00/BBL
($2.60/MMBTU)

OPERATING & CAPITAL *
$1.0/BBL
($0.17/MMBTU)
* NOMINAL CASE ECONOMICS

PETROLEUM
REFINERY PRODUCTS

1 BBL CRUDE YIELDS
$23.20 VALUE-ADDED
PRODUCTS
($4.00 /MMBTU)

"VALUE ADDED" FACTOR = 1.45

POWDER RIVER BASIN COAL
16 MMBTU/TON
$7.00/TON
($0.44/MMBTU)

($/MMBTU BASED ON FEED STOCK)

CHARFUEL®
PROCESS
OPERATING & CAPITAL **
$17.00/TON
($1.06/MMBTU)
** ULTRA - CONSERVATIVE
CASE ECONOMICS

CHARFUEL®
PRODUCTS

1 TON RAW COAL YIELDS
$46.24 VALUE-ADDED
PRODUCTS
($2.89 /MMBTU)

"VALUE ADDED" FACTOR = 1.93

M1298079

I. Critical Elements for a Successful, Long Term National Energy Policy

An independent, "Made In America" energy policy cannot be based upon one technology or one source of energy but must be based upon a suite of plentiful, readily available energy resources which can be utilized to their maximum potential in an economically, efficiently, and in an environmentally acceptable manner. However, having said that, this policy must have a cornerstone. To date, that cornerstone has been imported oil. Unfortunately, the Administration's National Energy Strategy (NES) results in continued reliance on oil, including imported oil.

Prior to proceeding with our testimony regarding coal and coal technology, I would like to make a couple of points about oil imports. First, it is not the importation of oil, per se, that is bad but the dependence upon that foreign oil. Second, one of the premises of the NES is that the "free" marketplace should govern energy production. Unfortunately, the $15 to $20 per barrel market price is not the true economic cost of oil.

There are four hidden costs of imported oil that are not represented in the market price. These costs are not reflected at the gas pump, but they are very real costs to the U.S. taxpayer. The first hidden cost is a function of our current trade deficit which results in large part from the import of oil. Senator Wallop, in a speech before this Committee, indicated that each and every day we spend $180 million for imported energy. These dollars are draining out of our country rather than being spent to generate domestic capital or to enhance our own GNP by producing domestic goods and services. Nor do these "exported" dollars generate tax revenues for the Federal or any local government to reduce our national debt or to fund domestic programs.

A second hidden cost is the loss of economic development dollars and domestic jobs. Senator Wallop was referring to this cost when he said

> "Not only does our growing dependence on foreign supply jeopardize our energy and national security, it also threatens our economic well being. Recall the economic stagnation, high unemployment rates, double-digit inflation and soaring interest rates that accompanied the oil shortages during the 1970s."

As imported oil displaces domestic resources, revenue-producing jobs and the economic well-being of domestic industries are put at risk. For example, while our forces and equipment were liberating Kuwait, to date at the sole expense of the American taxpayer, every

Kuwaiti family, including those in the U.S., was receiving $4,000 a month from oil generated revenues. This, while our coal miners' families are going hungry.

Another hidden cost of oil is the military/political cost. We have just experienced a $600 million/day war in the Middle East, for a total estimated cost of $56 billion. In addition, we were compelled to forgive millions of dollars in debt, owed by Egypt and other members of the Arab alliance, solely to keep the alliance intact. If these costs were added as a surcharge per barrel of imported oil, we would find a number of alternative technologies much more competitive.

The fourth hidden cost is probably the most expensive but also the most difficult to quantify. Oil producing nations reap tremendous income by export of oil. Although it is true that some of these dollars find their way back in the United States in the form of reinvestment, many U.S. dollars spent on foreign oil are used to purchase modern weapons. Many, perhaps even most, oil exporting nations have little or no middle class or domestic industry and are politically unstable - even volatile. When dictators such as Hussein of Iraq or Assad of Syria have access to weaponry, which will no doubt soon include nuclear weapons, our entire world is in jeopardy. Because the world is so dependent on the oil resources of these third world countries, we are subject to energy blackmail by over-armed, undereducated power structures we have created and paid for.

Another indirect cost, which is not so hidden after the Exxon Valdez incident, is an environmental cost. As we have seen in the Persian Gulf and in Alaska, the ultimate cost of shipping crude oil is hard to measure in dollars. Additionally, opening up reserves such as the Arctic National Wildlife Reserve has some environmental consequences, regardless of how small the proponents assert the impact will be.

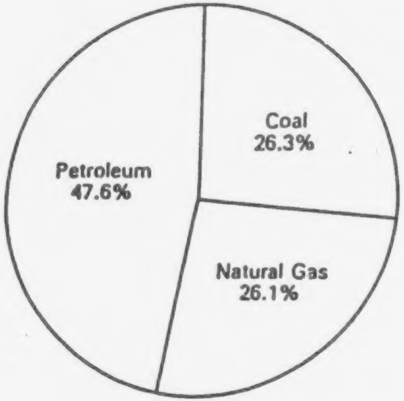
A. Adequacy of Supply

During the twentieth century, petroleum has served as the cornerstone of our energy industry, giving rise to a complex infrastructure based on liquid hydrocarbons refined from oil. Optimally, domestic petroleum would displace much of the oil which is now imported. However, our reserves are woefully insufficient for that precious resource to serve as the cornerstone of an independent energy strategy into the twenty-first century.

According to the Department of Energy statistics for 1988 (see Table I), the United States consumed 5.9 billion barrels of petroleum (3.4 quadrillion Btu or "quads"). In 1989 consumption increased to about 6 billion barrels (3.41 quads) (see Table II). In contrast,

TABLE I

U.S. FOSSIL FUEL CONSUMPTION, 1988

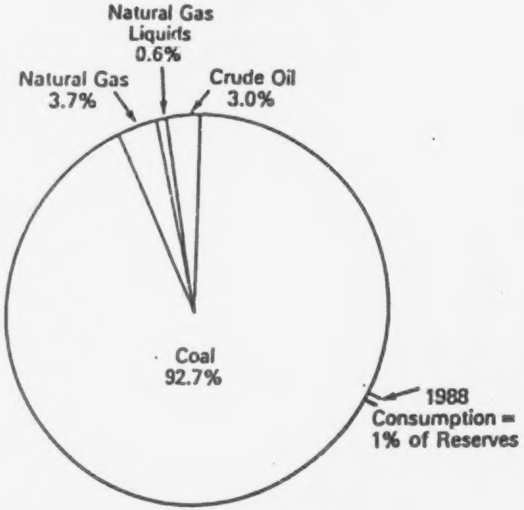


Consumption: 71.4 Quads

	Units	Quads
Coal	856.0 Mill S. Tons	18.8
Natural Gas	18.0 TCF	18.6
Petroleum	5.9 Bill Bbl	34.0
Total		71.4

Source: *Annual Energy Review 1988*, DOE/EIA, May 1989

U.S. FOSSIL ENERGY PROVED RESERVES



Proved Reserves: 5,247.3 Quads

	Units	Quads
Coal	237.3 Bill S. Tons	4,863.6
Natural Gas	187.2 TCF	193.0
Nat. Gas Liq.	8.1 Bill Bbl	32.4
Crude Oil	27.3 Bill Bbl	158.3
Total		5,247.3

(Note: Oil Shale Resources, 74 Bill Bbl, 429 Quads, not shown in Proved Reserves)

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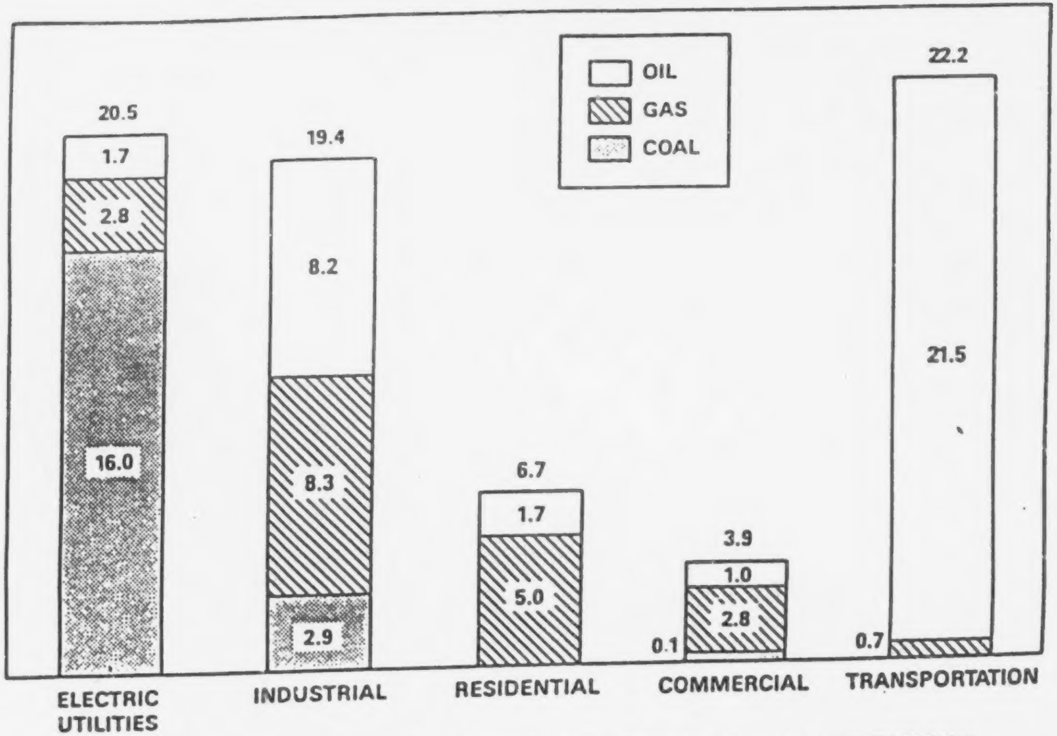
TABLE II

U.S. FOSSIL FUEL CONSUMPTION BY END-USE SECTOR, 1989 (QUADRILLION BTU)



SOURCES: MONTHLY ENERGY REVIEW DECEMBER 1989, DOE/EIA, MARCH 1990, TABLE 2.1.
ANNUAL ENERGY OUTLOOK 1989 & 1990, DOE/EIA, JANUARY 1989 & 1990, TABLE A2.

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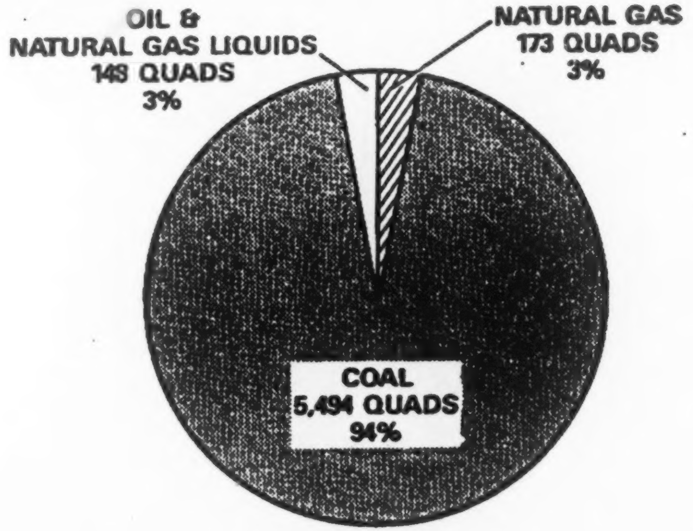
TABLE III

U.S. CONVENTIONAL FOSSIL FUEL RECOVERABLE RESERVES



5,815 QUADS TOTAL

COAL IS OVERWHELMINGLY THE MOST ABUNDANT U.S. FOSSIL FUEL RESERVE, AMOUNTING TO 94% OF TOTAL RESERVES, COMPARED TO 3% EACH FOR BOTH LIQUIDS AND NATURAL GAS.

SOURCE: U.S. RESERVES, DOE/EIA, SEPTEMBER AND OCTOBER 1989.

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Table I shows that as of 1988 proven reserves of domestic oil and natural gas liquids totaled 35.4 billion barrels - about 6 years supply at the 1988 rate of consumption. DOE revised estimates of recoverable reserves of oil and natural gas liquids as of 1989 were down to 27.5 billion barrels (see Table III) - just over 4 and one-half years supply at the 1989 consumption rate. Even if all the predicted 3.57 billion barrels of reserves in ANWR were recovered, they would meet only about seven months of U.S. consumption requirements. While domestic reserves of oil shale have been estimated at about 600 quads, most of it is of such low density as not to be recoverable in a thermally efficient or economical manner, i.e., too much rock must be heated for the small oil yield. The domestic reserves of uranium for the production of electricity in nuclear power plants must be part of any independent energy policy. However, without breeder reactors, which have been outlawed by Congress, the supply is about the same as for oil or gas. (See Table IV.)

Renewable energy such as wind, wave, and solar can also be used for production of electricity; however, these resources are very diffuse and are not compatible with our centralized power system. Further, they cannot meet our needs for transportation fuels.

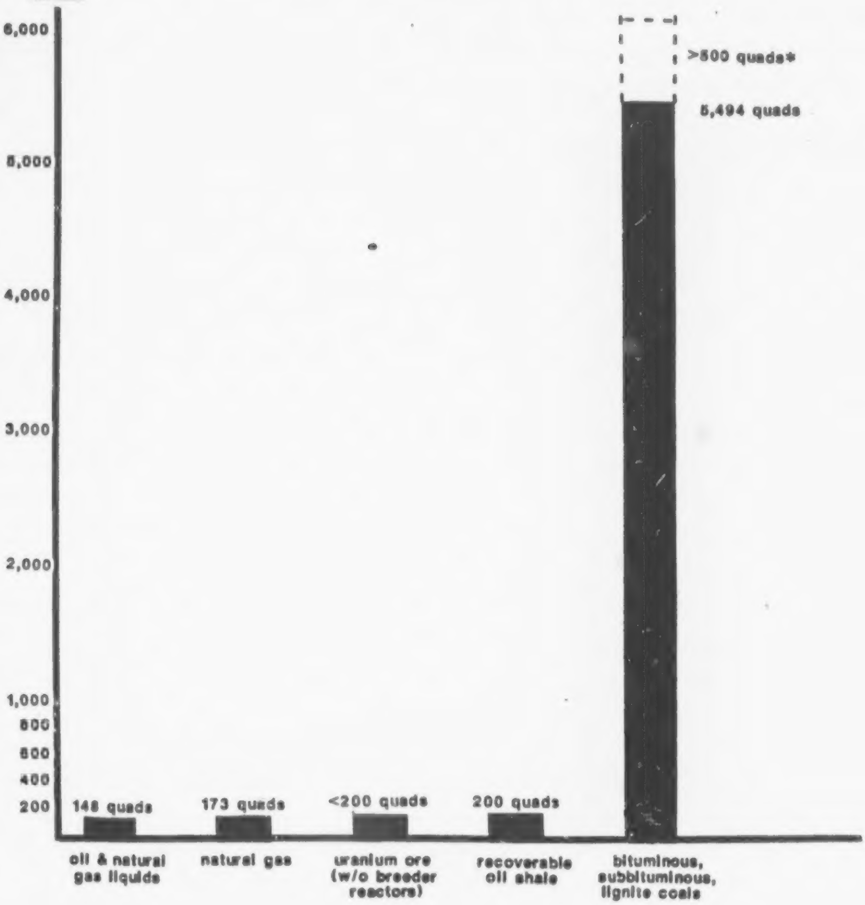
The good news is that known recoverable U.S. reserves of coal are adequate to meet all U.S. fossil energy requirements for over 75 years if this abundant domestic resource were refined in a manner similar to that used for crude oil. The resulting value-added products would be useful as boiler fuels and as transportation fuels and chemical feedstocks.

B. Resource Compatibility with Existing Infrastructure

The existing energy infrastructure focuses on the distribution of liquid and gaseous fuels, primarily via pipelines that criss-cross the country, to meet transportation and industrial needs. Refined petroleum products and natural gas cannot be easily or economically replaced for many of these uses. However, other fuels can be used to supplement domestic petroleum reserves to meet needs for lesser quality fuels and feedstocks. These "alternative fuels" must be compatible with existing marketing and distribution systems and with current forms of consumption, i.e., end use. While natural gas may be a substitute for fuel oil in residential and commercial heating units, it would be difficult to substitute compressed gas for a substantial amount of gasoline. In contrast, refined, coal-derived, liquid products can be shipped in existing oil pipelines for use in stationary boilers as well as for transportation fuels. Moreover, new technology makes these clean burning fuels available at a cost competitive with petroleum products when crude oil is priced at $10 to $15 per barrel.

TABLE IV

COMPARATIVE QUANTITIES OF DOMESTIC RAW FUEL RESERVES
(Quadrillion Btu)



* Waste and high sulfur coals, which are not economically recoverable for use in their raw state but would be useful as refining feedstocks, represent about 10% of total U.S. coal reserves

C. Energy Efficiency and Conservation

Energy efficiency and energy conservation are inextricably related and must, together, play a prominent role in any policy designed to wean this country from imported oil. While conservation is sometimes perceived as the elimination of frivolous or wasteful uses of a resource, in a broader sense, it also includes the most efficient use of a resource. Thus, the right form of energy must be matched to the intended use of energy.

Electricity is an example of a higher quality form of energy with an ability to meet a wide range of energy needs. However, electricity is not a primary energy source - it must be produced from a primary energy source, such as fossil fuels. For example, coal is burned to produce steam to run the generator which produces electricity. In a typical fossil fuel fired power plant, only about 32% of the fossil energy is actually transformed into electrical energy due to heat and mechanical losses. In moving the electricity from the plant to the user, there is a 5% to 7% transmission loss. In electric cars which operate on batteries, the electricity from a central station has to be converted to chemical energy, with an additional 10 to 15% loss. Finally, before the car can move, the chemical energy has to be turned back into electricity to drive a motor, which in turn is converted to mechanical energy resulting in a further 5 to 10% loss. Thus, out of 100 Btus of primary fuel used to produce electricity, only about 25 Btus are actually available to run the car!

The consumption of power for transportation is about 86 million Btus per day. At a 5% energy efficiency for electric cars, we would have to consume 172 quadrillion Btus per day of primary energy in order to completely replace gasoline powered vehicles. That would essentially require quadrupling our electrical generation capacity just to meet transportation power needs. The environmental advantages of electric cars are an illusion. While it is true that the cars themselves produce less emissions, power plant emissions associated with producing and transmitting the vastly increased requirements for electricity will skyrocket.

Alternative fuels produced by new coal refining technologies can be utilized exactly as refined petroleum products are used. Since pollutants are removed during the refining process and sold in existing markets, and because products from coal refining (like products from oil refining) can be tailored to specific uses, both process and use efficiency are increased. By reserving petroleum for those uses which cannot be met efficiently or economically by other energy systems and by producing a slate of value-added, clean burning products from its abundant coal reserves, the U.S. can simultaneously effect resource conservation and energy independence.

D. Environmental Compliance

A major deterrent to the expanded use of coal as a primary power source has been the air pollution associated with coal combustion. Much ado has been made in recent years about the reduction of sulfur emissions, comprised primarily of sulfur oxides (SO_x), from coal-fired facilities. Many clean air advocates embrace traditional flue gas desulfurization (FGD) devices to remove SO_x, but fail to take into account the significant drawbacks to the total environment caused by these devices. **Ignored are the substantial solid waste and increased CO_2 emissions which result from the use of scrubbers.** However, this situation is likely to change in the very near future.

The predominant FGD technique employs the so-called "wet limestone scrubber" which can reduce sulfur dioxide by over 90 percent. However, wet limestone scrubbers have little impact on NO_x emissions (another acid rain precursor), produce large quantities of solid waste **(about 2.4 pounds of sludge for every pound of SO_2 removed)**, and increase carbon dioxide (greenhouse gas) emissions **(about 0.7 pounds for each pound of SO_2 removed)**. Moreover, the toxics, such as chlorine and volatilized metals (eg., mercury, sodium, beryllium, and cadmium), which are regulated in the Clean Air Amendments of 1990 are removed from stack gases but are present in the scrubber sludge, making it a potential hazardous waste.

Because wet limestone scrubbers require a large amount of electrical energy to operate (up to about 5 percent of the total energy input to the utility plant) the amount of electrical energy available for sale is reduced. The overall effect is a decrease in the generating efficiency of the plant and a further increase in CO_2 production over the 0.7 pounds produced by chemical reaction. More fuel must be combusted to produce the extra power. This results in emission of additional carbon dioxide from the power plant as well as a greater volume of flue gas to be treated. Further, the mining and transport of this extra coal consumes energy and generates more waste and CO_2 emissions.

Based upon DOE estimates, a conventional 500 megawatt power plant utilizing wet limestone scrubbers over its lifetime will produce enough sludge to fill a 500 acre disposal pond to a depth of 40 feet. Assuming all of EPA's targeted 107 coal fired power plants (approximately 89,000 megawatts) installed scrubbers to meet the Phase I requirements of the new clean air legislation, the devices would produce enough sludge to cover the island of Manhattan to a depth of nine feet each year. Phase II of the proposed federal law represents another 56,000 megawatts of capacity. Using scrubbers to meet the Phase II criteria would produce an additional 2,200,000 acre-feet of sludge, enough to cover Manhattan with an additional 5.6 feet of sludge. Thus, scrubbers merely substitute ground pollution for air pollution.

The answer, of course, is not to clean up thousands of cubic feet of flue gas using technologies that produce solid waste and greenhouse gases, but to clean up the coal itself by "refining" out pollutants such as sulfur and nitrogen and potentially toxic materials in the same manner as in petroleum refining.

II. Coal-Derived Refined Products as the Cornerstone of a "Made in America" Energy Policy

As can be seen from Table III, recoverable reserves of U.S. coal represent about 95% of our total fossil fuel resource. Even if resources were re-allocated to provide industrial fuels and produce electricity from non-petroleum resources, the U.S. could not produce enough oil domestically to meet its requirements just for transportation fuels (21.5 quads per year based on 1989 consumption rates - see Table II). Quoting from a speech delivered by Mr. Robert Gentile, Assistant Secretary of Fossil Fuels, U.S.D.O.E., at a meeting of the University of Kentucky Mining Engineering Foundation,

> "The key is new, ultra-clean technology -- first demonstrated in the 1990's, then ultimately replicated and deployed in the 21st century... Coal is at the heart of our nation's energy capability. There is no better example of the truly massive energy strength of this country than its deposits of coal."

In our modern society virtually every mined substance is refined to produce useful products, such as iron, aluminum, copper, silver, titanium, and tungsten. Even table sugar and salt are refined. Except for coal, all of our fuels are refined: uranium ore, crude oil, and natural gas are refined.

Natural gas, as it comes out of the ground, contains impurities, such as CO_2, heavy hydrocarbons, and sulfur containing gases. These impurities are refined out prior to use to yield predominantly a single hydrocarbon compound: methane. Natural gas represents less than 3% of our known energy reserves.

Crude oil, as it comes from the ground, has limited utility. It is a dirty, sulfur-containing material. Hence, the petroleum industry has developed refining processes using hydrocracking techniques to produce value-added products, such as gasoline, jet fuel, and other hydrocarbon fuels and petrochemicals. Thus, gasoline refined from high sulfur crude or from light Arabian crude is still gasoline. Crude oil represents less than 2% of our known fossil fuel resources.

Raw coal, as it comes from the ground, also has limited utility. Like its "kissing cousin", crude oil, coal contains complex hydrocarbons, sulfur, and nitrogen. High sulfur bituminous coals and high moisture subbituminous coals are very different raw materials and cannot be interchanged as fuels but must be matched to specific boilers. However, the United States has 43% more energy in coal reserves than the energy equivalent of all the known oil reserves in the whole world. We cannot afford not to refine this valuable resource to produce clean, value-added products that mesh with our petroleum dominated delivery and distribution infrastructures. **Coal-derived fuels, feedstocks, and other refined products must be the cornerstone of our independent energy plan.**

A. The Coal Refining Process

Just as is it unimaginable that crude oil would be used in its raw form, so should it be unthinkable that we would merely burn raw coal. Obviously the question must be asked: Why not hydrocrack (refine) coal? It is a hydrocarbon just like oil and gas with just a lower ratio of hydrogen atoms to carbon atoms and a "ring" structure rather than a "chain" structure. Thus, any hydrocracking (refining) process for coal, while basically like that for oil, must be tailored to the characteristics of the coal molecule. However, the central point is that coal must be treated as the raw material it is; coal must be respected for the value-added products it can yield.

The coal refining process is not a gasification or liquefaction (synfuels) process which requires the addition of expensive oxygen or hydrogen or the use of extreme heat or pressure. Likewise, it is not pyrolysis or mild gasification that merely "cooks" the coal, producing coke and tar-like liquids and gas. Rather, the coal refining process is an efficient, economical means for utilizing virtually any type of coal (bituminous, subbituminous, or lignite; high or low sulfur) to produce a range of clean, value-added products which (1) are compatible with our petroleum-based energy transportation, distribution, and utilization systems, and (2) are competitive when crude oil is priced at less than $15/barrel.

The coal refining process, like the petroleum refining process, employs thermal hydrocracking of the complex hydrocarbons in the raw fossil fuel to produce char (coke) and liquid product. Process gases are recycled to avoid the need for external hydrogen. Hydrocracking involves the thermal breaking or "cracking" of larger hydrocarbon molecules in the feedstock and subsequent hydrogenation of the molecular pieces using hydrogen derived from the feedstock. In coal refining, inherent moisture is another source of hydrogen. In both processes, sulfur and nitrogen are removed during hydrocracking. The rearrangement of hydrogen within the coal molecule, so-called "hydrodisproportionation" (HDP), produces a slate of clean, value-added co-products, just as is done with crude oil in a petroleum refining process. The coal refining process is most analogous to the commercial hydrocracking of heavy crudes, bitumen or "tar sands".

Commercialization and deployment of coal refining technologies provide a unique opportunity to concurrently satisfy the following national goals: (a) comply with clean air standards (without producing solid waste) by removing potential pollutants from the fuel before combustion, (b) economically produce liquid transportation fuels from our most abundant fossil fuel resource, coal, while generating economical power, thus reducing dependence on foreign oil, (c) create domestic jobs and promote economic development based on a new coal refining industry, and (d) improve the U.S. balance of trade by creating a new export industry based on clean, coal-derived boiler and transportation fuels.

(i) Basic Coal Refining Facility

The most basic coal refining process facility is a mine-mouth plant which produces fluidic boiler fuel as its primary product along with naphtha, BTX, methanol, MTBE, elemental sulfur, and ammonia. The quantity of each upgraded product to be manufactured would be determined by market demand and coal feedstock characteristics. These quantities can be adjusted periodically without additional capital expense merely by changing operating parameters. This is the same system employed by petroleum refineries.

(ii) Coal Refining/IGCC Facility

Part of the objective of this Title V, and specifically Section 5001, is to "develop cost effective technologies or energy production processes or systems utilizing coal which achieve greater efficiency in the conversion of coal to useful energy". The coal refining/IGCC configuration is such a system, producing valuable petroleum substitutes, including refinery feedstocks, as well as electricity. This configuration meets the EPRI objectives of getting away from the Rankin cycle limitations.

The coal refining facility produces valuable petroleum substitutes such as BTX, naphtha, and fuel oil, as well as char which is used in the integrated gasification combined cycle (IGCC) facility to produce synthesis gas for combined cycle power generation and for producing products such as methanol. In this configuration, the objectives are to generate only that amount of sulfur-free fuel gas necessary to generate the optimum amount of

electric power for sale (in addition to the power necessary to operate the combined facility) and to maximize production of methanol and other upgraded products for sale as transportation fuels and as chemical feedstocks.

The major enhancements of the IGCC/refining concept are (1) directly producing high-value light organics (BTX) as well as naphtha and low sulfur fuel oil or refinery feedstock; (2) collecting the hot char under pressure and feeding it directly to an entrained flow gasifier, thus reducing oxygen and capital cost; (3) utilizing H_2 produced in the char gasifier to hydrogenate liquid hydrocarbons produced in the HDP reactor; and (4) utilizing CH_4 produced in the HDP reactor as fuel gas in a gas turbine.

(iii) Coal Refining/Cogeneration Facility

A third scenario, the coal refinery/cogeneration plant, directly produces valuable petroleum substitutes such as BTX, naphtha, and fuel oil, as well as oily char for steam cycle power generation. As in the previous configuration, the overall thermal efficiency of an integrated coal refining plant and a steam power generation unit is considerably higher than the thermal efficiency of a stand-alone steam power generation unit.

The major enhancements of the refining/cogeneration concept are (1) directly producing high-value light organics (BTX) as well as naphtha and low sulfur fuel oil or refinery feedstock; and (2) collecting the hot char under pressure and feeding it directly to a steam generator, thus increasing thermal efficiency and improving plant economics.

Modular cogeneration plants which can synthesize a range of products including fuel, building materials, chemicals, and metals in addition to electricity, may be made possible by a new spectrum of process technologies combined with "expert" diagnostic/control systems. The coal refining technology provides the building blocks to produce a mix of electricity, heat, liquid or gaseous fuel, plus marketable co-products compatible with the regional coal base and market potential. **The payoff is not just economic development, but also resource conservation and environmental protection on a broad scale.** Since the process "oil" produced in the coal refining process is similar in many respects to a low sulfur, highly aromatic #4 fuel oil, in either the stand alone refinery or both cogeneration scenarios, the process oil could be used as a feedstock to produce transportation fuels and petrochemicals or as a high heating value fuel oil. This would enhance the economics of coal refining and power production while reducing the amount of crude oil which must be imported.

B. Coal-Derived Refined Products

A commercial scale (10,000 TPD MAF coal throughput) coal refining facility using the fluidized hydrocracking process can produce, in varying quantities, char (which can be used as a boiler fuel, for manufacture of carbon products, or as a gasifier feedstock); fuel oil; BTX (benzene-toluene-xylene); naphtha; methanol; and MTBE. Potential pollutants are refined out to yield revenue-producing products such as elemental sulfur, ammonia, industrial grade carbon dioxide, and the salts of heavy metals and corrosive agents which would constitute air toxics if the raw coal were combusted. As can be seen by Table V, each of these co-products currently has a large domestic market which is expected to grow at the rates indicated. Prices shown for each co-product reflect the range during the last twelve month period, a time during which crude oil prices have fluctuated dramatically. The amount and quality of the various hydrocarbon liquids produced by coal hydrocracking is a function of the temperature and residence time. At longer residence times, heavier aromatic hydrocarbons are cracked to BTX and naphtha range hydrocarbons. By reducing the residence time, the amount of BTX and naphtha produced is reduced and the amount of heavier hydrocarbons increased. The additional heavier hydrocarbons can be sold as low sulfur fuel oil, as an oil refinery feedstock, or mixed with the char to produce a compliance fluidic boiler fuel.

A fluidic boiler fuel, produced by mixing the char with a portion of the process oil, can be shipped via existing oil pipeline for use as a slurry to fire or co-fire oil or coal electric generation or process heat boilers. As shown in Figure IV, the oil can be removed at the end-use facility and used as a feedstock or for turbine peaking. Since this boiler fuel has very low sulfur and nitrogen content, dramatic reduction in SO_X and NO_X emissions can be achieved without the need for scrubbers or special boilers. An additional advantage is that eliminating the need for pollution control equipment increases power plant efficiency, thus reducing production of "greenhouse gases".

The recovered and treated BTX can be used as an octane enhancer for gasoline or it can be separated into individual chemical grade components. If the toluene and xylene markets are depressed, these products can easily be de-alkylated to produce chemical grade benzene. If the benzene, toluene, and xylene markets are all depressed, the BTX can be economically hydrocracked to produce aliphatic and hydrogenated cyclic compounds (primarily gasoline fraction range).

TABLE V

CO-PRODUCT MARKETS AND PRICES

		CHAR/HYDROCARBON LIQUID BOILER FUEL $2.00/MMBtu (a)			CO-PRODUCT PRODUCTION EXPRESSED IN THOUSANDS OF TONS														
					AMMONIA $75 to $117/Ton (a)			BTX $1.20 to $1.80/Gal (a) (b)			METHANOL $0.35 to $0.60/Gal (a)			NAPHTHA $0.88 to $1.30/Gal (a)			SULFUR $90 to $113/ton (a)		
YEAR	IND. PROD. INDEX	UTILITY COAL USE. QUADS	COAL-REFINING PLANTS (c)	% COAL-FIRED UTILITY MARKET	TOTAL U.S. PROD.	COAL REFINING PLANT PROD.	COAL REFINING PLANT % OF TOTAL	TOTAL U.S. PROD.	COAL REFINING PLANT PROD.	COAL REFINING PLANT % OF TOTAL	TOTAL U.S. PROD.	COAL REFINING PLANT PROD.	COAL REFINING PLANT % OF TOTAL	TOTAL U.S. PROD.	COAL REFINING PLANT PROD.	COAL REFINING PLANT % OF TOTAL	TOTAL U.S. PROD.	COAL REFINING PLANT PROD.	COAL REFINING PLANT % OF TOTAL
1988	1.00	15.3	0	---	16,940 (d)	---	---	12,400 (d)	---	---	3,670 (d)	---	---	30,650 (d)	---	---	11,850 (d)	---	---
2000	1.52	22.6	1	.26	25,750	20	.08	18,850	135	.72	8,880 (e)	135	1.52	46,590	66	.14	18,000	79	.44
2003	1.64	25.0	3	.72	27,780	60	.22	20,340	405	1.99	9,580 (e)	405	4.23	50,270	198	.39	19,430	237	1.22
2005	1.76	27.6	5	1.09	29,810	100	.34	21,820	675	3.09	10,280 (e)	675	6.57	53,940	330	.61	20,860	395	1.89
2007 1/2	1.89	29.6	8	1.62	32,020	160	.50	23,440	1,080	4.61	11,040 (e)	1,080	9.78	57,930	528	.91	22,400	632	2.82
2010	2.02	31.4	12	2.29	34,220	240	.70	25,050	1,620	6.47	11,800 (e)	1,620	13.73	61,910	792	1.28	23,940	948	3.96

(a) Price for boiler fuel pegged at avoided cost of coal; other co-product prices for 1990 from Chemical Marketing Reporter.

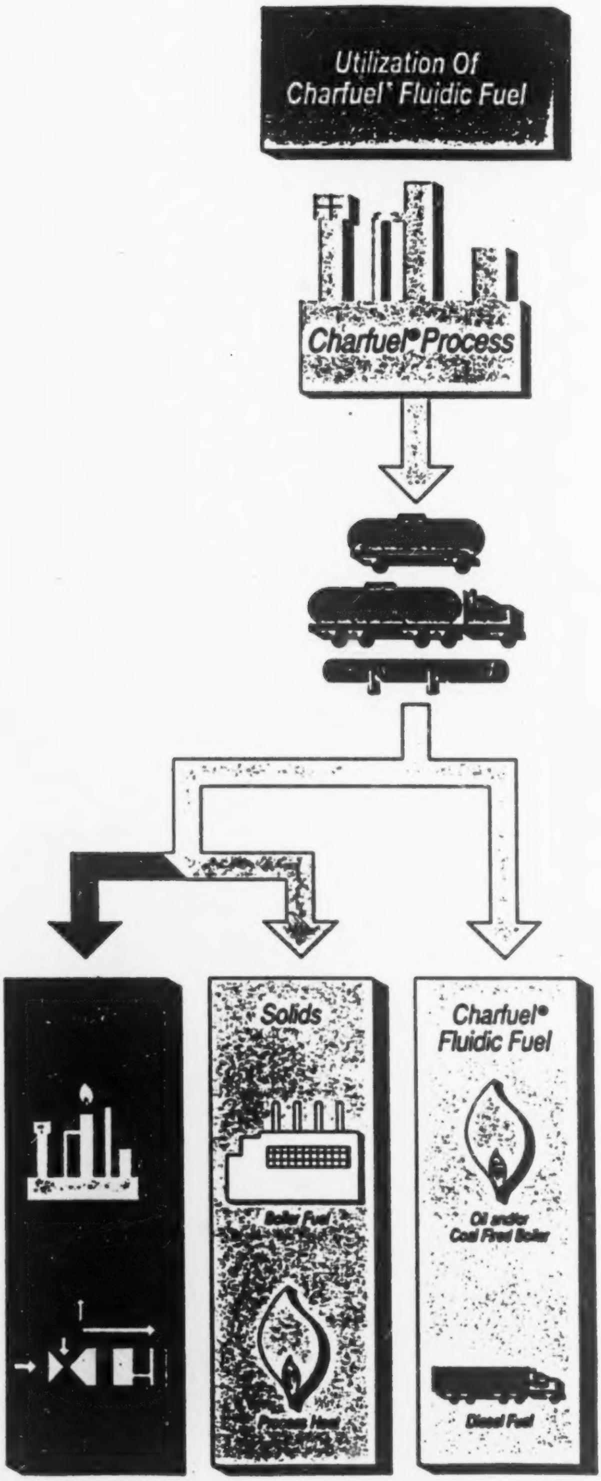
(b) Chemical grade Benzene varied from $1.30 to $2.00/gal in 1990
Chemical grade Toluene varied from $0.76 to $1.65/gal in 1990
Chemical grade Xylene varied from $0.78 to $1.55/gal in 1990

(c) Output for 10,000 TPD (MAF) Coal Feed = 60 Trillion Btu = 0.060 quads (quadrillion Btu)

(d) 1988 U.S. Production data from Chemical & Engineering News, June 19, 1989.

(e) 1990 Amendments to Clean Air Act will require about 3,300,000 tons additional methanol by 2000.

FIGURE IV



Utilization Of
Charfuel® Fluidic Fuel
Charfuel® Process
Solids
Boiler Fuel
Process Heat
Charfuel® Fluidic Fuel
Oil and/or
Coal Fired Boiler
Diesel Fuel

The recovered naphtha can be used as a gasoline blending stock or petrochemical plant feedstock. If these markets are depressed, the naphtha can be mixed with the fluidic boiler fuel.

The amount of methanol produced is a function of the amount of excess hydrogen produced in the POX reactor. If the methanol market is depressed, the amount of methanol can easily be reduced by producing less hydrogen in the POX reactor. Alternatively, additional methanol could be admixed with the fluidic boiler fuel or used to produce MTBE.

C. Coal Refining Process Economics

Price sensitivity analyses have been performed for Powder River Basin and Western Kentucky No. 9 coals in order to assess the impact of price fluctuations on base case economics. Each product price was independently varied ±20% and ±40% from base case prices. The results of the sensitivity analyses are shown on Figures V and VI. The sensitivity analysis indicates that the economic viability of the coal refining process is not particularly sensitive to fluctuations in the prices of the co-products. This is illustrated on the graphs by the relatively flat slope of plots for fluctuations in co-product prices.

The short residence time required for coal refining allows a much higher throughput rate in smaller reactor equipment. This, combined with mild operating conditions and high online factors, results in very low capital costs. Since the coal refining process requires no external hydrogen, operating costs are minimized.

As compared with the coal refining process, both liquefaction and gasification require extremely high capital costs, the addition of expensive external hydrogen, and/or catalytic reaction systems. Because of their relatively low thermal efficiencies and high operating costs, these processes are profitable only when crude oil prices are over $35.00 per barrel. In contrast, the coal refining process yields petrochemical products which are competitive even when crude oil is less than $15/barrel.

II. Impact of the Coal Refining Process

Fundamental problems facing the U.S. are (1) energy security, (2) balance of trade deficit, (3) environmental contamination, and (4) remaining competitive in an increasingly global economy. To remain competitive, domestic manufacturers must control costs, improve productivity and offer innovations in products and services not found elsewhere. Maintain-

FIGURE V

PRODUCT PRICE
SENSITIVITY ANALYSIS
POWDER RIVER BASIN COAL

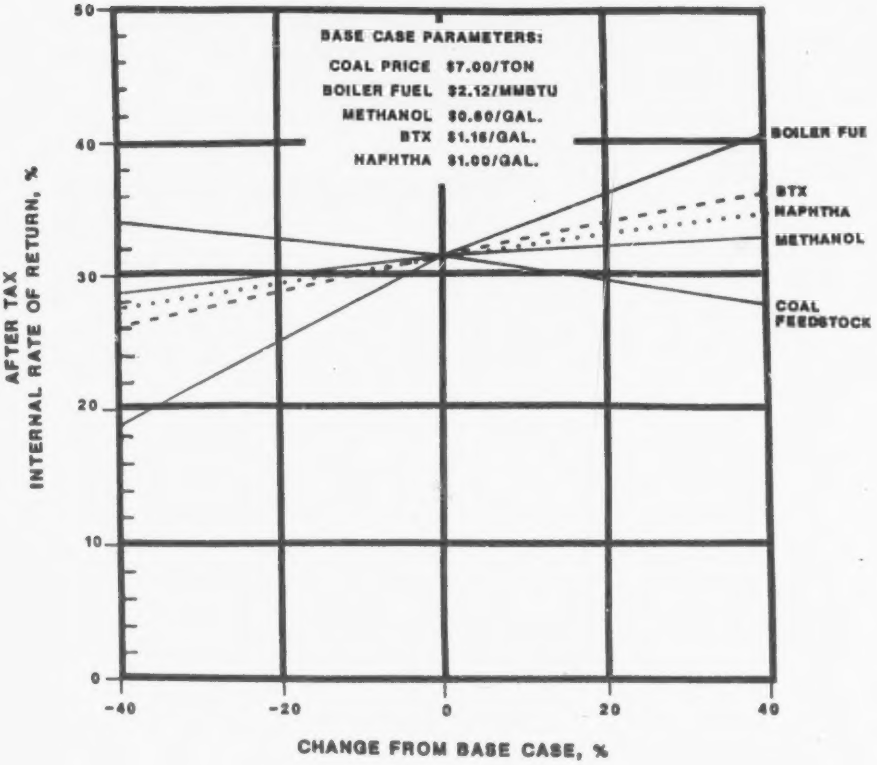
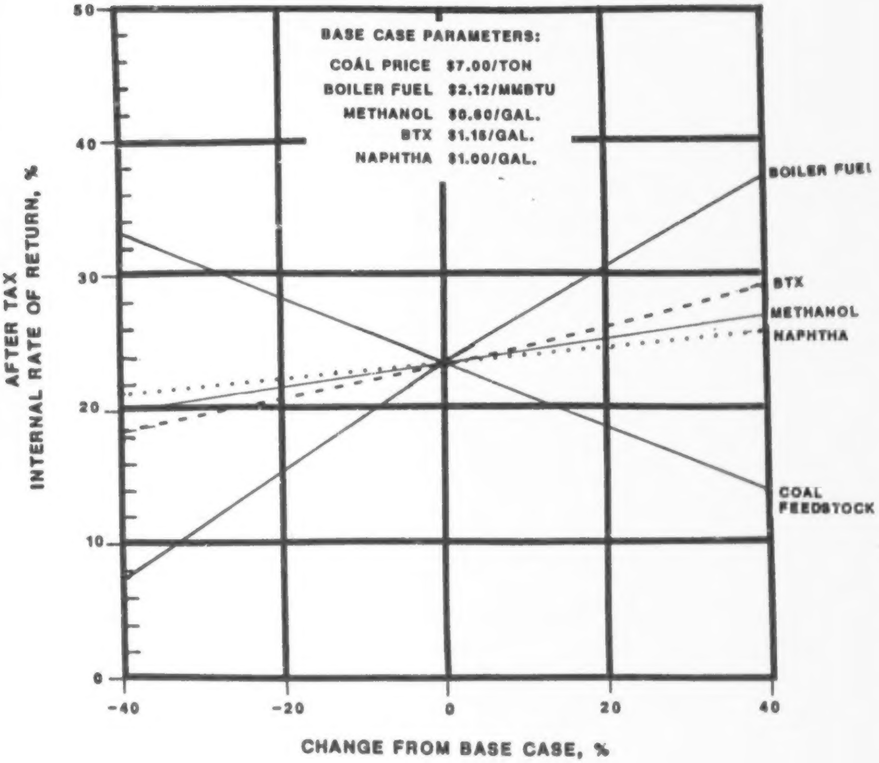


FIGURE VI

PRODUCT PRICE
SENSITIVITY ANALYSIS
WESTERN KENTUCKY #9 COAL



ing a secure, least cost electric power supply is one essential element of this strategy. Substantially reducing dependence on foreign oil is another. Unless electricity costs to critical industries are kept in check and fuel supplies are secure, the whole U.S. economy is threatened. As Senator Wallop so accurately stated,

> "As a trading nation, we require the unhindered flow of resources to sustain economic viability. No commodity is more essential than energy to a modern society, yet its production is largely taken for granted until we are told we may have to do with less or pay more for it."

In order for an energy system to be successful, the fuel must be economically producible, distributable, and usable. The most successful fossil energy system is currently based on petroleum. The reasons for this are:

- Crude petroleum can be refined to produce a number of revenue generating ("value-added") products that can be varied depending upon market demand;

- Refining of crude oil yields uniform, liquid products which are relatively easy and inexpensive to transport, store, and handle;

- The petroleum refining process can be fine tuned to produce only those products which have existing markets, favoring those products which yield the greatest economic return.

In a fossil fuel energy infrastructure dominated by refined liquid and gaseous hydrocarbon fuels, coal, in its raw form, cannot meet complex energy needs. The drawbacks associated with use of raw coal include its non-uniform composition which requires changes in boiler design for each particular type of coal; its bulky, solid form which results in transportation and handling problems; and its release of sulfur and nitrogen oxide pollutants which are commonly blamed for smog and acid rain. RAW COAL IS TOO VALUABLE JUST TO BURN.

The coal refining process emulates the petroleum refining process by producing uniform, economical, efficient, and environmentally acceptable fluidic products that fit into our existing distribution and delivery infrastructure. The United States' future energy needs can be met by applying petroleum refining concepts to our most abundant fossil fuel: coal.

Coal refining technology provides the same advantages whether the feedstock is high sulfur eastern coal, western subbituminous coal or lignite. Petroleum substitutes refined from

U.S. coal will supplement domestic crude oil reserves, thus reducing the need for imported oil. By relying on U.S. resources to meet our energy requirements, we can enhance our national security.

Coal-derived liquid refined fuels can be transported easily and inexpensively in existing crude oil pipelines to coastal ports, loaded aboard oil tankers, and exported to such markets as Japan, Korea, Taiwan, and Europe, helping our negative balance of trade. These products, derived from U.S. coal, are highly competitive in overseas markets, particularly those in the Pacific Rim. At present, U.S. coal exports are declining. This trend can easily be reversed by lowering the fuel transportation costs and making available a stable resource base (U.S. coal).

Just as crude oil is a feedstock for manufacturing value-added products, so coal can be utilized to produce a slate of nonpolluting, economical fuels as well as chemical feedstocks. Because valuable co-products are generated by the coal refining process, the refining facility will utilize the coal feedstock more efficiently and in greater quantities, resulting in increased mine production and increased severance tax revenues. Thus, application of the coal refining technology will not only permit cost-effective reduction of SO_2 and NO_x emissions but also will encourage economic development in regions where refining facilities are located. The refining facilities themselves are also environmentally benign, producing no environmentally incompatible waste streams. The only effluent is clean flue gas.

In the coal refining process, approximately 2 ton equivalents of coal are required to make about 1 ton equivalent of boiler fuel and about 1 ton equivalent of value-added co-products which are salable to non-traditional coal markets. **This results in double the demand for raw coal**. Thus, there is an economy of mining because of large scale operations. Since the coal refining process can be applied to a wide range of coal feedstocks, there is no need to "hi-grade" or waste material in order to meet contract requirements. Mine mouth plants can be located in all coal producing states, not only increasing mining jobs, but also employing operators for the refinery and creating new jobs for support and spin-off industries.

A total of 750 full-time employees would be required to operate both a 10,000 TPD coal refining facility and the coal mine(s) dedicated for supply of 4 million tons per year of coal feedstock. Annual income from these new jobs would amount to over $30 million per year. An estimated additional 1,100 jobs would be created in the local area to provide support for the permanent 750 new jobs created for the coal refining facility and coal mines. Moreover, spin-off industries for utilizing or marketing the slate of co-products will add to the employment base. Locally, these new jobs result in higher property values, increased tax revenues and enhanced community services. At a state level, increased mining and industrial infrastructure contribute increased mineral royalties as well as individual income and corporate taxes.

Thus, the coal refining process, particularly the Charfuel® process, provides a unique opportunity to concurrently satisfy four national goals: (a) reduce dependence on foreign oil by efficient, economical utilization of domestic resources, (b) improve balance of trade by creating a new export industry, (c) continue the substantial progress made in emission control by resolving the conflicts between coal use and overall environmental protection, and (d) meet the challenge of economical power generation which must result in reduced cost and increased productivity.

IV. Conclusion

The legislation proposed by Senators Johnston and Wallop was intended to create a "balance" among energy alternatives. To further that goal, we believe additional attention should be paid to maximizing the deployment of American technology to utilize America's most abundant fossil fuel. Senator Johnston correctly noted that

> "Our energy situation seems comfortable to many Americans, and so we resist change. But we are sowing the seeds of great difficulty in the near future with our growing dependence on imported oil, our slowing pace in improving energy efficiency, and our delay in developing alternative sources of energy such as nuclear energy and renewables."

We would simply add that delays in commercializing coal refining processes which emulate commercial petroleum refining processes are exacerbating an existing energy crisis. The proposed legislation makes a start in mandating that within 8 months the Secretary develop a report on the status of advanced, coal-based technologies, and developing a plan for conducting research, development and demonstration of such technologies. However, we concur with Senator Wallop

> "...[O]ver the long-term we must implement the energy policy we develop. It does no good to once again produce a report that sits on the shelf collecting dust."

Rather, we urge that the Secretary's mandate include federal support of the commercialization of coal refining technologies which will meet the triple goals of (1) supplementing domestic production of transportation and power generation fuels; (2) reducing dependence on imported oil; and (3) cost effectively and efficiently producing electrical power without producing noxious emissions.

We support Senator Wallop's position that

> "Fundamental to the success of any national energy strategy is that it be sufficiently flexible for all domestic energy supply and demand alternatives to compete in the market place. Frankly, the current energy situation provides an opportunity to promote competitive, market-oriented energy policies that rely on the strengths of our energy industry."

Energy is such an all-pervasive factor in the life of the nation that any change in the energy system must be undertaken with a minimum impact on industry and society. Otherwise the economic and psychological costs will be such that no new energy strategy will be able to overcome the inevitable resistance. Therefore, moving into a renewable energy economy will take more time than is available if we are to avoid an energy disaster. Similarly, ideas such as electric cars not only challenge the energy infrastructure but mask the very central issue, namely that electricity is not a primary energy source, but must be generated from fossil, nuclear, or other primary energy sources.

Nevertheless, there appears to be a general concurrence that a national energy security policy must include the twin objectives of (i) rapid movement toward energy self-sufficiency and (ii) maximum consideration for environmental health and safety as well as economic security. The national and economic security of this country remains highly threatened so long as over 50% of our petroleum and petroleum products (nearly 25% of our total energy) is imported. It is tragic that our country's well-being should be vulnerable to foreign manipulation when we have the means to achieve energy independence. Moreover, the means exist to do so in an environmentally acceptable manner, even improving on existing environmental conditions, through renewed focus on coal, our most abundant fuel source.

The strategy for achieving both objectives must:

(1) be based on the total energy reserves of the United States, maximizing the use of more abundant resources while conserving more scarce resources;

(2) recognize the appropriate roles for each fuel type within the context of the present energy infrastructure;

(3) promote technological development of improved processes and uses of each fuel type;

(4) apply a systems approach to resolving energy-related issues, from fuel acquisition and production through end use.

(1) The DOE data show that the approximate recoverable U.S. fuel reserves are: oil, 200 quads; natural gas, 200 quads; uranium, 200 quads; shale oil, 600 quads (of which only about 200 quads are efficiently or economically recoverable); coal, 6,000 quads. There is 10 times more energy in coal than in oil, natural gas, and uranium combined. In fact, coal represents 83% of our entire fuel resource. Therefore, any legislation creating or implementing a national energy strategy should properly emphasize the use of coal, possibly by reserving a title for coal (as, for example, the National Energy Security Act of 1991 does for oil and natural gas).

(2) Establishing an appropriate role for each fuel type implies optimizing the use for the fuel based on quality as well as quantity. Such a strategy is a high form of conservation. It is also a means whereby scarce liquid and gaseous fuels can be utilized for mobile and dispersed use, such as for transportation fuels and home heating, whereas abundant coal can be utilized for stationary and centralized use, such as generation of electricity and process heat, as well as for producing refined products.

(3) Significant technological breakthroughs are critical to the national energy strategy. We have seen how such breakthroughs, some of which have had a difficult time in winning approval, facilitated the successful outcome of the recent Gulf war. Break-through technology literally made the oil industry. It can do the same for coal, provided the incentives exist for government, industry, and academia to focus on such break-through technology. One such possibility is to recognize that optimum process technology eliminates pollutants from the fuel rather than controlling their emission by expensive clean up and waste treatment methods. For coal, this means pre-combustion technology rather than combustion or post-combustion (e.g., flue gas scrubbing technology).

(4) A systems approach is essential to proper analysis of economic and environmental costs and benefits. For any fuel type, this must include the economic and environmental costs of producing, processing, shipping, storing, handling, using, and disposing of wastes. With oil, for example, the environmental and economic costs of oil spills and of

automobile catalytic converters must be considered in addition to the more traditional costs. With coal, it is not sufficient to determine the cost of scrubbing flue gases; the economic and environmental costs of disposing of solid sludge and CO_2 must also be considered. A system analysis compares such costs (as well as the benefits) for particular fuel types in a given application, thereby permitting intelligent choices to be made.

We cannot overstress the need for this Committee to ensure that this bill, or any amended national energy policy, include support for the technological breakthroughs possible by the refining of coal, in particular the application of hydrocracking processes as is done with petroleum. Such federal support would, in a reasonable time, permit coal to shoulder its fair share of the burden to achieve national energy security.

ASSOCIATION
OF AMERICAN
RAILROADS

William H. Dempsey
President

March 18, 1991

The Honorable Wendell H. Ford
Chairman, Subcommittee on Energy Research
and Development
Committee on Energy and Natural Resources
United States Senate
Washington, DC 20510

Dear Mr. Chairman:

On behalf of our member railroads, which collectively move more than 90 percent of the nation's rail freight, I request that the following comments on S. 341 be inserted into the hearing record.

The freight railroad industry is strongly opposed to Section 5008 of S. 341. Section 5008 requires the Department of Energy (DOE) to monitor railroad coal rates. It would require DOE to study rail coal rates from January 1, 1988 through December 31, 1997, and to submit interim reports to Congress in 1993, 1995, and 1998. Ostensibly, the purpose is to determine if reregulation of the railroads is necessary.

Section 5008 would have DOE monitor rail coal-rate increases occurring as a result of the Clean Air Act Amendments of 1990 and "other Federal policies," plus monitor increases or decreases in the revenue to variable cost ratios of coal transportation rates, and any electric rate increases that might be attributable to higher coal transportation costs.

For more than 100 years, Congress has charged the Interstate Commerce Commission (ICC) with such functions. In fact, the ICC continues to monitor rail coal rates. Railroad coal rates were not completely deregulated by the Staggers Act. No other agency in government has either the knowledge or expertise to perform such a function.

However, our objection to Section 5008 extends well beyond the fact that DOE is an inappropriate agency to monitor railroad coal rates. Such additional economic scrutiny of the railroads is

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unnecessary, it will be counter-productive to the intent of Congress to reduce and eliminate needless economic regulation, it unjustly singles out railroads for special new regulatory burdens, and it will impose substantial new costs on railroads and the federal government.

When Congress passed the Staggers Rail Act of 1980, it made a finding of fact that failure of the railroad industry to achieve increased earnings would result in either further deterioration of the rail system or the necessity for additional federal subsidy. Congress determined that demand and competition were to be the principal regulators, and that regulation of maximum rates -- by the ICC -- was to continue only where an absence of effective competition exists. This has been the policy of the ICC since passage of the Staggers Act, and it has worked for the benefit of coal shippers, the railroads and the public.

More than a decade of experience under railroad deregulation is available for study -- and the results prove overwhelmingly that the Staggers Act is accomplishing precisely what Congress intended in 1980. Railroads have achieved, on a daily basis, freedoms from governmental interference and enhanced abilities to price their services according to market forces.

These freedoms allowed railroads to survive a long and deep recession of the early 1980s, a shift in the U.S. economy from basic production, a downsizing of many manufactured products, substitution of lighter materials for heavy ones, unabated foreign competition for U.S. export markets, a growing domestic reliance on imports, and the unparalleled competitive pressures ensuing from trucking deregulation.

Although the railroad industry remains demonstrably revenue inadequate, the financial malaise that characterized the industry during the 1970s has been removed. Instead of an industry distinguished by a high rate of bankruptcies, deferred maintenance, service deficiencies and rising accident rates, today's rail freight carriers have been investing at record levels in new plant and equipment, have been winning back traffic from the highways due to superior rate and service offerings, and have improved their safety record substantially. Clearly, coal shippers and the public have been a major beneficiary of the Staggers Act.

Railroad rate increases -- especially those on coal -- have been so modest as to have trailed inflation consistently since the Staggers Act was passed. According to a study by economists at the Federal Trade Commission, annual consumer savings from partial rail deregulation -- lower rates, more timely and more reliable service -- have topped $15 billion. The U.S. Department of Justice reported that rail service improvements came from efficiency gains and were not accompanied by an increase in rail rates.

Further, the U.S. General Accounting Office has reported: "Rail service has improved for many shippers, and railroads generally are more responsive to shippers' needs." The GAO cited contract ratemaking as "one of the most significant benefits" of the Staggers Act through which "shippers receive reduced rates and improved service in return for volume commitments," allowing them to "better plan their operations and investments and thus enhance their competitiveness." Some 60 percent of total rail traffic now moves under contract, including 86 percent of coal traffic.

Indeed, coal shippers have been especially fortunate under rail deregulation. Since passage of the Staggers Act, rail coal rates -- when adjusted for inflation --declined by more than 10 percent. For a commodity that places an inordinate burden on railroads -- almost 40 percent of tonnage -- coal's contribution to railroad revenues is only 22 percent.

Much of the increased investment in plant and equipment over the past decade has been for the benefit of coal, which often is moved in 10,000-ton unit trains that place severe stress upon track and track structure in much the same manner as heavy trucks create severe stress on pavements. Over the past 10 years, railroads have invested more than $30 billion in new plant and equipment, plus spent in excess of $100 billion on maintenance. Tens of millions of research dollars have been directed specifically at means of hauling heavy loads such as coal more productively.

The efficiency improvements of railroads, combined with the moderation in rate increases, is why not a single piece of legislation was introduced in the 101st Congress to amend the Staggers Act. In fact, only one coal-rate complaint was filed with the ICC in 1989, only one complaint in 1990, and none at all so far in 1991.

Clearly, there is no demonstrated need for saddling the railroads with additional economic regulation or regulatory burdens. Such regulation would be expensive -- both to the railroads and to the government. This is because, as stated, 86 percent of coal moves under contract -- at negotiated rates whose terms, by law, are confidential. In order for a government agency to perform the detailed analysis required by Section 5008, either that confidentiality would have to be ignored (which coal shippers, as much as railroads, would oppose), or special new reporting requirements and confidentiality safeguards would have to be adopted. Further, Section 5008 is very similar to a provision rejected last year by the House.

One of the fundamental causes of rail financial difficulties during the 20th century has been unique treatment of the railroads. For example, railroads continue to be singled out for special treatment in the areas of injured-employee liability (the Federal Employers' Liability Act, or FELA) and labor relations (secondary boycotts).

Section 5008 is another attempt at such unique treatment. Not only is no other mode so singled out, but neither is the transportation of any other energy source. Such unique treatment of railroads also is rejected by the Administration's national energy strategy, which recommends the repeal of FELA and a prohibition of secondary boycotts against railroads and airlines as exists under the Taft-Hartley Act for all other industries. The committee should not exacerbate the inequities to which railroads are subject by allowing Section 5008 to remain in the bill.

Rather than treating railroads as an impediment to national energy policy, Congress should recognize railroads as a complement to that policy. Railroads transport freight in the most fuel efficient and environmentally safe manner of any of the surface modes. Government studies show railroads to be three times more energy efficient than their principal competitor, heavy trucking; and when upstream return of barges is considered, railroads also are more fuel efficient than their inland waterways competitors.

In fact, according to the President's national energy strategy, railroads use just 2 percent of petroleum consumed by all transportation modes. And because railroads consume so much less fuel than their competitors, they are environmentally preferable. According to a recent study performed for the Environmental Protection Agency, railroads hauled three times the ton-miles of trucks but emitted just a fraction of the hydro-carbons, carbon-monoxide, nitrogen oxide and particulate matter as motor carriers.

Finally, railroads offer a solution to congested and deteriorating highways. According to the Federal Railroad Administration, railroads could handle four times their current volume of freight with minimal expansion (and all of that expansion financed through the private sector).

Although the AAR will file a separate statement for the record to cover other energy issues, it should be recognized that a current motor carrier proposal to increase the length and weight of trucks on our highways would have a further debilitating effect on those highways, the rail industry, and shippers who depend on railroads for essential transportation services.

Some trucking interests are arguing for massive increases in truck sizes and weights: the legalization, nationwide, of 135,000-pound twin 48-foot double trailer combinations, and 115,000-pound triple-trailer trucks. These would be the largest increases in truck size and weight in the nation's history. Yet even these larger rigs would be less fuel efficient than rail by a 2-to-1 margin.

The impact of bigger trucks on the rail industry would be devastating, diverting up to 20 percent of rail ton-miles to the highways and reducing rail net revenues (profits) by up to 50 percent. The truckers' proposal amounts to a recommendation that America move to an almost exclusively highway-based system of freight transportation. Having just fought a war, one of whose elements was energy supplies, any move to increase truck sizes and weights seems exquisitely ill-timed due to the impact it would have on railroads, rail shippers, and the general public.

We urge the Committee to delete Section 5008 from the bill, or in the alternative, to expand the provision to cover all forms of energy affected by the Clean Air Amendments of 1990 and "other Federal policies." Continued unique treatment of railroads cannot be justified.

Sincerely,

W. H. Dempsey

Senator FORD. Senator Craig, do you have a statement you would like to give?

Senator CRAIG. Not at this time.

Senator FORD. Mr. Secretary, you are up. We look forward to your testimony, Mr. Secretary, and if you want to file it for record, you can, and hit the highlights. Or whatever your pleasure is.

STATEMENT OF ROBERT H. GENTILE, ASSISTANT SECRETARY FOR FOSSIL ENERGY, DEPARTMENT OF ENERGY, ACCOMPANIED BY JACK SIEGEL, DEPUTY ASSISTANT SECRETARY FOR COAL TECHNOLOGY

Mr. GENTILE. Mr. Chairman and members of the committee, I do propose to briefly summarize my prepared testimony and would ask that my full statement be submitted for the record.

Senator FORD. Without objection, it will be included in the record as if given in total.

Mr. GENTILE. Thank you. Also at the table with me is Mr. Jack Siegel, the Deputy Assistant Secretary for Coal Technology. He is prepared to assist me in answering any of the more detailed questions that you or the committee may have.

Mr. Chairman, there is much in title V; it is consistent with the directions we are taking within the Department for coal and coal technology development. Our program, as my formal statement indicates, is adopting the policy guidelines set forth in the National Energy Strategy.

These are (1) to maintain coal's competitiveness while meeting environmental, health and safety requirements, and (2) to create a favorable export climate for U.S. coal and U.S. coal technology.

I believe an overall reading of title V would indicate that the bill has the same general goals. The National Energy Strategy identifies the clean coal technology program as the department's principal means for achieving these goals. Because I know you and other members of this committee have a specific interest in the clean coal program, let me take a couple of minutes to clarify the administration's position.

We have not decided to cancel round 5. Our fiscal year 1992 budget request calls for a suspension of the final round, a breathing period, you might call it. And during that breathing period, if Congress approves, we will assess several factors. I have listed some of these factors on page 4 of my formal statement, but let me expound.

The coal-fired power industry of the 21st century will confront very stringent emission caps imposed by the new Clean Air bill. That will represent entirely new challenges for future power plants, as well as challenges for continued operation of plants that are in existence today. Also, the global climate change issue remains a concern. It is clear that the world's industrialized nations are going to be under increasing pressure to take mitigating actions, even before all the science is in.

Tighter regulations of air toxics is also becoming a fact of life. Air toxics were addressed in the Clean Air bill, and future coal plants will likely have to incorporation technologies that meet as-yet undefined regulations. We may also see increasing priority given to security of liquid fuels, and that could change our thinking or perhaps broaden it in terms of what the fifth round of the Clean Coal program should be.

In short, we may need to restructure the solicitation for round 5 differently from those previously. For example, we may need to develop an approach that attracts the more advanced technologies, technologies that may not actually achieve final maturity and commercial readiness until the 21st century. In light of this, we believe the most prudent action is to pause at this point and examine all of these factors. And that is what we proposed in our 1992 budget submission.

Many of these factors are also playing a role in defining the direction of our coal R&D program. I provided a few of the examples of the technology achievements that have come out of this program in the past 11 years, but the list is considerably longer. We are currently preparing a comprehensive report on these successes, and the report is to be completed by the end of April. And I will forward copies to this committee as soon as it is finished.

In my formal statement I have described several of the new directions being taken in the coal R&D program. Specifically, we are reorienting the program towards those advanced technologies that can keep coal competitive in the 21st century.

Again, we see many similarities between the high-efficiency, superclean concepts we are now emphasizing, and the general directions outlined in title V of the bill we are discussing today.

The final pages of my formal statement include a section by section review of title V, and rather than discuss each item separately, let me make a couple of points.

First, in several areas, we have conducted or continue to conduct many of the activities called for in title V. Aspects of our program, for example, have developed technologies that produce nonfuel forms of coal. One of the clean air demonstration projects now under construction will test the technology that could be used for this purpose.

We have conducted an extensive program in coal-fired heat engines, including some major success in developing coal-fired diesel locomotives. We have taken measures to expand and better coordinate promotion efforts for coal and coal technology exports.

Yet, Mr. Chairman, we must recognize that our resources are limited, and this is the second and final point of my statement. Where we have had to choose between R&D that can keep coal strong in its current markets, or that might some day expand coal's markets, we have placed the highest priority on the former. That means our program must emphasize advanced technologies for the power generation market, where 85 percent of the coal now mined in the United States is used.

While we do not quarrel with all the merits of the R&D for coal-fired turbines and diesels or nonfuel uses of coal, limited resources mean that we cannot pursue every worthwhile approach. However, even though we may differ about the relative emphasis on different technologies, we commend the sponsors of the legislation for recognizing the importance of coal as one of the Nation's energy mainstays.

And as I have indicated in my formal statement, we want to work with the committee to develop a legislation package that reflects that importance. That completes my opening statement, Mr. Chairman. I would be pleased to answer any questions.

[The prepared statement of Mr. Gentile follows:]

Statement of
Robert H. Gentile
Assistant Secretary for Fossil Energy
U.S. Department of Energy
to the
Committee on Energy and Natural Resources
U.S. Senate
on
March 19, 1991

Mr. Chairman and Members of the Committee:

I am pleased to provide the Department of Energy's views on title V -- Coal, Coal Technology and Electricity -- of the National Energy Security Act of 1991.

Title V's recognition of the important role for coal and advanced coal technology in both domestic and international markets is consistent with the view of coal expressed by the recently released *National Energy Strategy* (NES). Coal represents 90 percent of all known U.S. fossil energy resources, and as the NES states:

> *"The magnitude of this resource, coupled with the multiple uses for coal and coal-derived products (including the manufacture of synthetic fuels), ensures that coal is likely to be a major contributor to the Nation's energy supply-mix for the foreseeable future."*

The NES establishes two major goals for federal coal-related initiatives, both of which are consistent with the general themes of title V. These NES goals are:

1) Maintain coal's competitiveness while meeting environmental, health, and safety requirements; and

2) Create a favorable export climate for U.S. coal and coal technology.

The NES's major effort to achieve these goals is through the continued implementation of the Clean Coal Technology Program.

Based on its five-year history, the Clean Coal Technology Demonstration Program must be considered one of DOE's recent "success" stories. Its purpose is to co-finance with industry a series of pioneering projects that will demonstrate innovative methods for using coal cleanly and efficiently.

Since the program was conceived -- as a $5 billion commitment to the U.S./Canadian effort to resolve the transboundary problem of acid rain -- 35 projects, representing 10 major categories of technology, have been selected from three rounds of nationwide competition and are now active.

Sponsors of 33 of the projects have now received cooperative agreements and are progressing through their intended demonstration effort. Seven projects are now operating, and another six are scheduled to be in operation within a year.

Within just the last few weeks, for example, the following major milestones have occurred:

- -- the first electricity generation from American Electric Power's 70-megawatt pressurized fluid bed combined cycle plant in Ohio;
- -- the startup of a gas reburning (for nitrogen oxide reduction) and sorbent injection (for sulfur control) technology installed at an Illinois Power Company plant;
- -- the startup of an advanced nitrogen oxide reduction process at a Georgia Power Company plant;
- -- the groundbreaking for a new "coal refinery" -- a plant that will produce both clean solid and liquid fuels -- from subbituminous coals in Wyoming.
- -- the first operation of an advanced pollution control device invented by the Passamaquoddy Indian Tribe that uses previously discarded waste dust from a cement kiln as a scrubbing reagent.

These projects, and many others in the program, are now generating the construction and operational data that will be needed for the private sector to make more cost-effective pollution control and power generating decisions in the near future. In addition, many of the longer-range technologies, which incorporate ultra-clean emission performance levels and extremely high efficiences, can help position coal for the 21st century both domestically and internationally.

Indeed, as the March 4, 1991, issue of *Forbes* magazine points out in its article "Coal Comes Into Its Own:"

> *"...coal is on the verge of becoming part of the solution to the world's environmental problem rather than one of its causes."*

DOE is beginning to reorient both its Clean Coal Technology Demonstration Program and its Coal Research and Development Program toward technologies that can meet the environmental and energy supply demands of the next century. In addition to high levels of pollutant removal, the Department is also stressing power systems that operate at significantly greater efficiencies than today's conventional coal-burning processes (40-60% efficiency levels versus 33% for today's units).

Increased efficiences -- i.e., extracting more useable energy from a given amount of coal -- has both environmental and economic benefits. Formation of carbon dioxide -- one of the so-called "greenhouse gases" -- can be reduced significantly (20 to 40%) by boosting power plant efficiencies through advanced technology. Greater power output also lowers the release of other pollutants and can result in lower cost electricity to the consumer.

Round #4 of the Clean Coal program is offering additional credit for technologies that achieve high efficiency levels. Round #5 will also emphasize ultra-high efficiency processes in the context of addressing post-2000 energy and environmental demands. Other considerations for Round #5 include meeting future energy needs under the Clean Air Act emission caps and the need for technologies that can respond to energy security goals, evolving air toxics regulations, and continuing concerns over solid waste management.

In fact, one of the principal reasons DOE would prefer to delay Round #5 beyond its currently scheduled date is to allow time to restructure the present solicitation approach. We believe that the nation would best be served by developing an approach that attracts the most advanced technologies possible within the basic tenets of the Clean Coal program's mandate. A task force charged with examining these issues has been established.

The FY 1992 coal research and development budget also is being reoriented to place greater emphasis on technologies that will maintain coal's competitiveness in the 21st century.

During the last 10 years, DOE's coal R&D program has made great progress and has laid a solid foundation for future advances. We have identified more than 40 technologies that have been developed under DOE sponsorship. Almost half of these technologies have either entered the commercial marketplace or have been selected for demonstration under the Clean Coal Technology Program.

Some technologies that have not yet reached the commercial stage themselves have spun off technologies that are undergoing large scale demonstration. For example, research on the magnetohydrodynamics technology has led to the development of advanced slagging combustors.

Examples of technologies that have emerged from, or been assisted by, the DOE coal R&D program and are now being commercialized or demonstrated are:

- Commercial-scale coal-burning fluidized bed combustion
- Fluid bed methanol-to-gasoline conversion
- Once-through liquid phase methanol production from synthesis gas
- Advanced gas cleanup systems for coal gasification power generation
- In-duct sulfur dioxide control
- Improved coal cleaning processes (microbubble column froth flotation)

There has also been progress at small scale development units in reducing the cost of liquid fuels from coal and increasing the efficiency and cleanliness of power generation.

The proposed FY 1992 coal R&D program builds on these successes and looks to positioning coal for the 21st century -- e.g., wrapping up work on acid rain technologies and emphasizing technologies that respond to post-2000 Clean Air Act requirements, help mitigate global climate change concerns, and can meet future energy needs.

Consistent with the goals of the NES, the FY 1992 and subsequent coal R&D budgets will focus increasingly on ultra-clean and/or ultra-high efficiency processes that can reduce acid rain precursors by 95 percent or more, and can lower carbon dioxide emissions by 20 to 40 percent.

Although overall proposed budget levels have been reduced, reflecting deficit reduction requirements, the FY 1992 coal research and development program will continue to sponsor:

a) extremely effective flue gas cleanup technologies (with a greater degree of sulfur capture than today's scrubbers and with the integration of nitrogen oxide controls);

b) more efficient "hot gas" cleanup techniques that can improve the cost-effectiveness and environmental performance of advanced power generating equipment such as gasification-combined cycle and pressurized fluidized bed technology;

c) higher-performance combustion processes, such as advanced generation fluidized bed concepts and low-emission boiler systems;

d) advanced generations of fuel cells;

and

e) improved techniques for producing synthesis gas and coproducts from coal.

In addition, DOE's fossil energy program will expand its efforts in FY 1992 to examine innovative techniques for controlling greenhouse gas emissions principally through higher efficiency technologies and techniques for the removal and disposal of carbon dioxide.

As I have said, the coal-related priorities reflected in the NES and the Department's FY 1992 budget request are generally consistent with title V of the proposed act.

With this overview of the NES and coal R&D program as a backdrop, let me address the specific sections of title V of the proposed legislation:

Section 5001

Section 5001 authorizes the Department to conduct a research, development and demonstration program for advanced coal-based technologies with the goal of *"achieving the control of sulfur oxides and oxides of nitrogen at levels of proficiency greater than currently available commercial technology."* It also calls on the Department to design a program that can *"assure the timely development of cost-effective technologies or energy production processes or systems utilizing coal* *__which achieve greater efficiency__* *in the conversion of coal to useful energy...."* [underscoring added].

We believe the composite efforts of the Clean Coal Technology Demonstration Program and the Coal Research and Development Program are consistent with the effort envisioned by Section 5001.

Section 5002

Section 5002 would commission a plan for a research, development and demonstration effort for several non-fuel uses of coal. Traditionally non-fuel uses of coal have been outside the main mission of DOE's fossil fuel program. DOE does not currently have an explicit coal R&D program in this area; however, DOE has had underway for several years efforts to broaden the slate of coal-derived products. For example:

- The gasification/co-products program is developing technologies capable of producing coke and other carbon products from coal;
- The coal preparation program is addressing resin extraction from western coals;
- The coal liquefaction program is developing liquid fuels and feedstocks capable of producing the full slate of petrochemicals.
- The coal waste management program includes an effort to develop commercial uses for coal-derived waste products.

In addition, one of the most recent Clean Coal Technology Projects to move into construction is based on a "coal refinery" concept -- a plant that would produce several forms of value-added liquid, gaseous and solid products. Although the ENCOAL project, near Gillette, Wyoming, will produce both a low-sulfur liquid substitute for Number 6 fuel oil and a clean solid with the quality of a bituminous coal, the technology can also produce non-fuel products. This multi-product facility could be an economically competitive venture far sooner than a plant that produces a single product.

DOE is currently preparing a report requested in the Conference Report accompanying the FY 1991 Department of Interior and Related Agencies Appropriations Act that will assess various coal refinery concepts from economic, technical, environmental and market perspectives. Although the principal focus is on processes that produce an array of fuels, the report will discuss non-fuel opportunities. The report is due to Congress on or before July 31, 1991.

In another Clean Coal Technology project (the Air Products and Chemicals Inc., project), methanol production from coal-derived synthesis gas will be demonstrated. The suitability of using the methanol product as a low SO2/NOx alternative fuel in boilers, turbines and transportation applications will be determined. Although these are fuel applications, the same technology would be suitable for producing methanol as a chemical feedstock.

Given this, it does not appear that a separate program in this area is needed. The merits of technologies developed solely for non-fuel uses should be weighed carefully against the need for ensuring that sufficient funding is provided for technologies that are critical for ensuring that coal remains a viable energy supply option.

Sections 5003 and 5004

Both sections deal with the export of coal or advanced coal technology. The provisions in each are consistent with the importance placed by the National Energy Strategy on the international dimension of coal use and coal technology.

As the NES points out, in 1990, the first year in U.S. history during which more than a billion tons of coal were mined in this country, more than 100 million tons were exported. Electricity demand and the use of coal for power generating and industrial processes are growing rapidly worldwide. Yet, at the same time, the same environmental concerns that are present in the U.S.

have emerged in many other countries; and this has produced some apprehensions about an expanded role for coal.

There is no reason for the world to turn its back on coal. DOE has developed a more aggressive posture in recent months to ensure that countries are apprised of the benefits of advanced coal technology and, in turn, can look increasingly to U.S. coal suppliers for purchases of reliable coal supplies.

We see the bulk commodity and the technology to use it cleanly as going hand-in-hand. In concert with the Departments of Commerce and State, we are aggressively promoting this linkage in trade missions and other discussions with our overseas trading partners.

Through this expanded outreach effort, the U.S. has an opportunity to provide a leadership role in promoting international economic growth without compromising worldwide environmental objectives. Advanced hardware, such as that being demonstrated in the Clean Coal Technology Program, could improve the quality of life significantly in many countries, including some in the Third World as well as in Eastern Europe.

The National Energy Strategy has called for a unified federal export promotion effort, and DOE is currently consolidating its export activities. The Administration supports a mechanism comparable to the Committee on Renewable Energy Commerce and Trade (CORECT) for technologies in addition to renewable technologies. We believe the export promotion of clean coal technologies should be handled within this context.

We also believe that the focus of any such mechanism should not only be on lesser developed countries but also on the significant need for environmental cleanup efforts in the emerging democracies of Eastern Europe.

Regarding the data and information dissemination systems called for in Section 5004(e), the Department is already in the process of creating a coal technology export clearinghouse. This clearinghouse, which is also an initiative called for by the National Energy Strategy, would provide information to domestic and foreign companies on laws, regulations, market issues, advantages of U.S. technologies, etc.

Section 5005 and 5006

These two sections single out coal fuel mixtures and coal fired locomotives for specific reports and/or research, development and demonstration programs. Both have been important elements of DOE's ongoing coal R&D program for many years. We would be pleased to respond to the legislation's request for a report summarizing the status of technologies for coal fuel mixtures within one year following enactment, as called for by the bill.

Regarding specific research, development and demonstration of coal-fired locomotives, the Department has had significant efforts underway in this area. In July 1986, the Department completed a major assessment of alternative approaches for returning coal to the locomotive. This assessment identified the coal-fired diesel engine as the most promising approach for displacing a significant portion of the nearly 3 billion gallons of diesel fuel used by the U.S. locomotive fleet annually.

In 1987, we completed an assessment of combustion characteristics for coal particle fuels in medium speed diesel engines typical of those used by the railroad industry. In 1988, we completed an assessment of the technical feasibility of the coal-fired diesel engine. This assessment identified the component and material modifications that would be required.

Work is now underway, principally with the General Electric Co., to develop a prototype "proof-of-concept" coal-fired diesel engine. General Electric has made significant advances toward this goal, especially in the development of more wear-resistant components. The company should have a railroad locomotive incorporating a prototype coal-water slurry fueled diesel engine operating on its test track this summer.

DOE, however, has proposed to discontinue its work on coal-fired diesel and other heat engines in its FY 1992 budget. While important, this development is not considered to be as high of a priority as other elements of the coal R&D program which are critical to maintaining coal's current energy supply contribution. We believe that funding can better be spent on high-efficiency, ultra-clean power generating options and on ways to reduce the environmental impacts of long-term coal use. Furthermore, the private sector companies which are the potential producers of these technologies should have enough information to assess the potential market penetration and economic and technical viability.

Section 5008

Section 5008 would authorize the establishment of a data base within DOE containing transportation rates (with appropriate confidentiality provisions), and a study of coal transportation rates. Given the important role that transportation costs play in the delivered price of coal, both for U.S. and domestic markets, a data base could be very useful in understanding how transportation costs may or may not affect coal's use in particular markets. The NES recognizes the need to provide coal shippers the maxmimum number of transportation options by supporting legislation to grant Federal eminent domain to coal slurry pipelines that meet regional and State water use concerns.

Conclusion

We commend the sponsors of the legislation for recognizing the importance of continuing to look toward coal as one of the nation's energy mainstays. We would be pleased to work with the Committee in developing a legislative package that implements the important elements of both the proposed legislation and the NES.

This concludes my prepared statement.

Senator FORD. Thank you, Mr. Secretary. What do you mean by a breathing spell between round 4 and round 5 of the new technologies that are being presented to the Department?

Mr. GENTILE. In the course of the last year, we delayed round 4 about 6 months because of the Clean Air bill. We now have a solicitation on the street; we are moving forward with round 4. What it means is that we need to rethink how a round 5 should be structured, given some of the changes in the Clean Air Act and the technologies that we will need as we cross the line into the 21st century.

And the Secretary has made it quite clear that he plans on revisiting this entire issue in the fiscal 1993 budget process. Under the current law, however, we are to proceed with the solicitation in March of 1992. The Secretary has also made it clear that if the law does not change, the Department will proceed in March of 1992.

Senator FORD. I hope your breathing period is not an underwater breathing period; it will be kind of short.

One thing that bothers a lot of us and I would like to get this question on the record. Since the money is already there, do you plan on reprogramming any of the money? The money has already been appropriated.

Mr. GENTILE. In the 1992 budget request, we have asked the $150 million from the Clean Coal program be used as an offset on the R&D. And the reason for that, quite honestly, is that we would not have spent that money in 1992 under any scenario for the current rounds of the Clean Coal Program. So we were not going to use that money in 1992.

Senator FORD. But once it is gone, it is gone, is it not? Unless you come back up here and ask for $150 million.

Mr. GENTILE. That certainly is a difficulty at this point, yes.

Senator FORD. What do you mean it is a difficulty? You can answer that yes or no, can you not?

Mr. GENTILE. I think that in 1993, the Secretary's intent was to get that $150 million back in 1993 under round 5. And it is to be revisited in 1993.

Senator FORD. Well, you know something? I do not believe you are going to get to transfer that $150 million. Because what you are saying to me is that here is the money, and it has been appropriated and it is available; you want to take it and shift it, and then you want to come back up here and see if you like it. And then you come back and ask us for another $150 million. I do not think that is going to wash. And you can tell the Secretary that.

Did the Department consider including any incentives for clean coal technology in its NES legislation?

Mr. GENTILE. No, sir. At that point in time, we did not. We thought that most of the coal issues could be handled through the administrative process. Most of the initiatives—did not require legislation.

Senator FORD. This is almost a repeat Go ahead. This is a repeat of what we heard on uranium enrichment, you know, a couple weeks ago. Same scenario. And it is beginning to develop a pattern that some of us have a hard time following.

Mr. GENTILE. There were some incentives in the President's original submission of the Clean Air bill that I believe passed the

Senate and then did not make it through the final conference. And of course, while we continue to support the President's initiatives in those areas, we would be happy to work with the committee on that.

Senator FORD. You would be willing to work with the committee on appropriate provisions to include something in this legislation?

Mr. GENTILE. Yes, sir.

Senator FORD. Has that been signed off by OMB?

Mr. GENTILE. The incentives proposed by the President in his Clean Air bill were concurred on by OMB and other Federal agencies who worked on the bill prior to being sent to Congress for consideration.

Senator FORD. Let me ask you something. Do you have any idea of how the round 5 of the clean coal technology—I want to get you back into that, between those two lines, if I can. How would the program be restructured and restructured to do what?

Mr. GENTILE. Well, basically, Mr. Chairman, in round 5, we have to concentrate on those very high-efficiency, superclean technologies that we need as we move into the 21st century. And those are the technologies we are talking about, many of which are mentioned in this piece of legislation, but there are also others.

We are currently looking at how we would restructure round 5 to meet those objectives. But we are basically talking about the more advanced, superclean, high-efficiency technologies.

Senator FORD. Did I understand in your statement that you said that task force has been established to analyze the whole issue?

Mr. GENTILE. Yes, sir.

Senator FORD. What will the task force do now? Structure the task force for me.

Mr. GENTILE. Well, the task force is an internal DOE task force with members from headquarters and the Pittsburgh and Morgantown energy technology centers. We are looking at where the program has evolved. We are looking at the legislation, we are looking at the types of technologies we are going to need in the 21st century, and we will try to figure out exactly what the parameters of a round 5 should be. Let me turn to Jack and see if Jack wants to add anything to that.

Mr. SIEGEL. Mr. Chairman, there are some limits under the current law as to what we can do in the clean coal program, and how far we can push technology.

In round 4, we have moved the solicitation more toward the post-2000 technology, the high-efficiency technologies. But we feel in reading the legislative language that we have from Congress that we really cannot go very much further in that direction.

So one of the things the task force is looking at is, how would we like to see the next solicitation structured? What kinds of technologies will we be looking for? And as a result, what legislative changes would be necessary in order for us to pursue those approaches?

Senator FORD. Since you refer to the law, does the law say the solicitation must be done by March 1, 1992?

Mr. SIEGEL. Yes, sir.

Senator FORD. Will you ask for change in the law to delay that date?

Mr. **Siegel**. That is something that is being reviewed. I think the Secretary has taken the stance that if Congress does not change the law, that we will proceed with round 5.

Senator **Ford**. Do I understand that you want to delay it, if you have your way, until 1993?

Mr. **Siegel**. I think the issue it really comes down to is not technology oriented. I think there are probably enough technologies that would be ready to compete in a March 1992 solicitation. The issue is the timing of when we can get a good solicitation together. Several issues effect the timing.

If we are going to be selecting round 4 projects in September of this year, we will then be negotiating those round 4 projects over the next year. Our staff is going to be dedicated to getting the round 4 projects under way.

If EPA is going to be in the process of promulgating regulations for toxic air pollutants, and the post-2000 requirements under the new Clean Air Act, we were just thinking that it would be of value to have an opportunity to get a lay of the land some time toward the end of this year, then have some public meetings to get the public's input to the round 5 process as we have done with the previous solicitations. And then prepare a new solicitation.

Senator **Ford**. Well, if you are allowed to spend $150 million, then you can think whatever you wanted to think, and then can do whatever you want do. If you do not have money you cannot go round 5, can you?

Mr. **Gentile**. We have the money right now to start the process. We would not need the money in fiscal year 1992 to fund the project selected for clean coal programs. In other words, that money was appropriated, but was not going to be——

Senator **Ford**. But the money is there, and you are asking to use it in another field, are you not?

Mr. **Gentile**. Yes, sir.

Senator **Ford**. But if that money is gone and you do not request the additional $150 million, then that solicitation is gone, is it not?

Mr. **Gentile**. That is true. There is another $450 million advance appropriated that would be used starting in 1993, I believe.

Senator **Ford**. Let me see if I can get you on record. Will you ask for changes in the law to delay the date?

Mr. **Gentile**. Yes, sir. We have done that in the 1992 budget. We have asked for a delay of that date. The Secretary has said, however, that if Congress did not go along with that delay, that he would proceed according to the law to do the solicitation in March of 1992.

Senator **Ford**. You mentioned in your statement that one of the clean coal projects located in Wyoming is based on a coal refining concept. Tell the committee a little more about that, will you please, sir?

Mr. **Gentile**. Yes, this is a project that is called ENCOAL. I think it is at the Triton mine. It is a technology that produces a slate of products. It takes the coal, it basically puts it through a pyrolyzing process. It turns out a solid fuel and it turns out liquid fuels. It can adjust the process to really put out a slate of products.

Senator **Ford**. Is it similar to the SRC-1 program that was tried several years ago?

Mr. **Siegel**. No, sir, no, sir, it is not. This is a technology that will produce a wide variety of fuels. The SRC-1 was going to produce a solid fuel product.

Senator **Ford**. It could be liquid or a solid, could it not?

Mr. **Siegel**. There was an SRC-2 process that would be a liquid. This is a combination of a slate of fuels, more like a coal refinery that would produce just a wide variety of——

Senator **Ford**. How much money was placed in this Wyoming project?

Mr. **Siegel**. A little over $36 million of the Department of Energy funds, 50/50 cost shared with industry.

Senator **Ford**. Well, if you are so keen on it, should we not have more money invested in coal-refining technology?

Mr. **Gentile**. We have quite a bit going on in different types of technology, sir, everything from mild gasification to liquefaction. This is both in the R&D program and also in different parts of the Clean Coal program.

Senator **Ford**. Are you familiar with the coal refining process that use hydro-cracking techniques?

Mr. **Gentile**. Somewhat, sir, yes.

Senator **Ford**. Well, is this an appropriate technology for DOE to invest in? What I want to know is this an appropriate technology for DOE to invest in?

Mr. **Siegel**. Well, yes, sir. We have in the past and continue to invest in a variety of coal-based technologies that produce liquid products.

Senator **Ford**. What has DOE done in response to the direction given in the fiscal year 1991 Interior appropriations to assess coal-refining concepts?

Mr. **Gentile**. We have a report that I believe is due in June of this year, and that report is well under way. It will be here on time.

Senator **Ford**. It will be here in June?

Mr. **Gentile**. In July.

Senator **Ford**. The National Coal Council has completed 10 reports since its inception, and they included seven reports that have had recommendations on clean coal technologies. To what extent has DOE followed the recommendations of the National Coal Council?

Mr. **Gentile**. I believe that as we look at the overall recommendations of the National Coal Council, we see most of them dealt with also in the NES. For example, the long-range role of coal in future energy strategy in the U.S., the council recommended that we should acknowledge the importance of coal; that is done in the National Energy Strategy. It talked about moving the clean coal technology program toward high efficiency and low environmental impacts; that is done in the National Energy Strategy.

Let science drive the environmental regulation; that is also the intent of the NES. Push towards improved energy efficiency worldwide, very much a part of the coal program as demonstrated most recently by our project in Poland, and also with the agreements that we are signing with countries in terms of moving technology.

NES should promote development and deployment of coal-derived synfuels, also a part of the National Energy Strategy when we talk about liquids; should facilitate efficient utilization of coal transport; should work with other agencies to develop a better, balanced approach to mining. That is all included in the National Energy Strategy, sir.

Senator FORD. Now tell me how much money you have requested to follow through on the National Coal Council's recommendations that you so eloquently laid out.

Mr. GENTILE. Well, I think that is part and parcel of the coal program within fossil. In 1992, we have requested——

Senator FORD. I just asked you how much money that you requested to back up all those projects that the council recommended and you say that you are supporting?

Mr. GENTILE. Well, it would be about $430 million.

Senator FORD. Where did you get the money? What did you take it away from? Is that just new money?

Mr. GENTILE. That is the money that is requested in the 1992 budget proposal for coal R&D and clean coal technology.

Senator FORD. It is a 1992 request.

Mr. GENTILE. It is a 1992 request.

Senator FORD. Where are you going to use the $150 million in that? Is that part of that request?

Mr. GENTILE. The $150 million would be used in the coal R&D section; the $227 million in the coal R&D, I believe, is $150 million used there.

Senator FORD. What type of regulatory barriers exist to commercial use of clean coal technologies?

Mr. GENTILE. The current problem that is most prevalent is probably the situation known as WEPCo, which requires some dealing with to make it more readily—use clean coal technologies.

In addition, we have also had a panel tell us—that we have some economic impediments that need to be dealt with taxes, including loans, grants, the regulatory impediments regarding prudency, incentive rate of return, some pass-throughs, and rapid amortization. And those are the issues that I referred to earlier that were in the President's Clean Air bill originally.

Senator FORD. Well, let me just—you know, you have wallowed all over the field there for me. Let me get down right close to it. The administration has proposed initiatives to eliminate or minimize regulatory barriers for other energy sources such as nuclear and for gas. But why not coal?

Mr. GENTILE. Sir, as I said earlier, I think we would be quite willing to work with the committee on those initiatives. The President already proposed for the Clean Air bill.

Senator FORD. I just asked you a question. Why not coal? You do that for the others, but coal is left out. Now you say when you get up in front of me you are willing to work. Well, how much are you willing to work? When you walk out that door, I guarantee there will not be much work going on unless we do it right here in this committee. So why did you not try to look at coal?

Mr. GENTILE. Well, sir, we are looking at several aspects of that. At WEPCo, we are activity working on it with the States. Those are the issues that we thought were most important at this point in time.

Senator **Ford**. We just finished up an excursion in the Persian Gulf, and everybody gives accolades to our military and what they have been able to do over there. But some have said that our energy strategy has been imports of oil, and we went over there to defend our imports.

But yet when you look at coal and how much we have of that all across this country, we find that you have left it almost completely out. You can talk a good game, but then when the time comes to put up or shut up, you shut up. And then when you get in here, you say you want to work with us, you want to do something about it. Well, it's obvious you were not thinking much about it, did not have much push for it beforehand, until you run into some of us who like to see something more done for coal.

I do not like this idea, either, of appropriating money for certain projects that we think are good and then you do not spend it because you do not like it. Somewhere along the way you are going to have to start doing what Congress asks you to do, instead of trying to get around it by doing what you want to do and saying you are saving money.

I do not mind you saving money, but I also worry about some programs that are being delayed that should not have been delayed. The last 10 years, we have not done anything as it related to what was initially started in 1980.

I am going to stop now for a while and call on Senator Burns. Oh, excuse me, Bennett. Mr. Chairman, I am glad to see you.

The **Chairman**. Thank you, Senator Ford. I will go ahead and take my regular time. I see Senator Burns is all wound up there with a good question. I will just wait my time.

Senator **Ford**. What about the Ranking Member?

Senator **Wallop**. I will have a couple of questions.

Senator **Burns**. Thank you, Mr. Chairman, I thank the Ranking Member and the chairman. I have just a few questions, and some of them I will probably submit in writing, Mr. Secretary.

I happen to be one that likes just not this whole business of just digging coal and shipping it off somewhere to burn it. I like a value-added product, and I think we are going in the right direction whenever we talk about refining and refining technology that we can do with coal.

I think every State looks for ways to provide jobs, not only produce a product that takes care of our SO_2 and our NO_x, all of these things that we do not like spewing in the air. Maybe we can get away from the old mechanical scrubbing of our utilities and that type thing.

I am wondering, it just seemed to be that the thrust of the bill—and I would ask you, why does DOE seem to emphasize post-combustion cleanup rather than focusing on cleaning of the fuel? Would that not be both more economical and more efficient?

Mr. **Gentile**. I would say, Senator, that our emphasis is on combustion. We are moving towards those technologies that can use any fuel, and clearly the more advanced technologies are in that realm. Instead of having to clean the coal up ahead of time or having to clean the post-combustion gases, our thought is it is most efficient if we burn it in an environmentally sound way and not have to deal with cleanup, front end or back end.

Senator **Burns**. I noted with great interest after visiting with Mr. Reilly, who is over at EPA, and EPA's thrust seemed to be a thing dealing with problems before they occur, rather than cleanup. What is DOE's interpretation of "achieving greater efficiency," does this only apply to electric power generation, or does it apply to producing coal-derived refined fuels?

Mr. **Gentile**. It applies to both. In the utility sector, we are clearly looking for facilities which have increased thermal efficiency while at the same time being superior environmental performers. We would also look at some of these refining processes as being efficient in that they pull several products out of the coal.

In the project that we will be breaking ground on this week, it is a project in the State of Montana with Western Energy, it is a process to dry out the coal and therefore making it more efficient in terms of transporting and everything else. So we are looking at it from a whole range of aspects.

Senator **Burns**. What coal refinery concepts are discussed in the report that you mentioned just a little while ago with the chairman? In your testimony, which is being prepared for Congress, could you give us an overview of what that report will look like?

Mr. **Gentile**. I am sure there will be a whole range of issues. They would normally include those of coal refining, the mild gasification, the pyrolyzing—anything else that you can think of?

Mr. **Siegel**. We are going to look at a wide variety of processes, the economics, the technical aspects and identify whether or not there are any research and development needs.

Senator **Burns**. Do they include hydro-cracking?

Mr. **Siegel**. Yes, they would.

Senator **Ford**. They say they are going to look at it? And the report is due in June?

Senator **Burns**. Yes. I was kind of switching horses here. Since there was positive language in the administration's National Energy Strategy regarding support for Federal eminent domain for coal pipelines, why was such language not included in S. 570, and that is the administration's bill? Or does the administration intend to submit a separate legislation for coal pipelines and/or do you think such a provision should be made a part of this legislation here, S. 341?

Mr. **Gentile**. We are studying that further right now, Senator. These bills have always been introduced pretty much up here, and at this point in time we are going to be looking at that further. But it was a thought that this had really been a congressional initiative in the past, and I guess we expected the initiative to be up here at this point.

Senator **Burns**. Mr. Chairman, in regard to time and everybody getting their questions in, I have some more questions, but I will submit them in writing, if you will permit me to do so.

Senator **Ford**. I would be glad to do so, and ask that they respond in a timely manner.

Senator **Burns**. And thank you very much.

Senator **Ford**. Senator Johnston.

STATEMENT OF HON. J. BENNETT JOHNSTON, U.S. SENATOR FROM LOUISIANA

The CHAIRMAN. Thank you, Mr. Chairman. I do not have a lot of questions, Mr. Gentile, other than to just say that we are very interested in this committee in these clean coal initiatives. We want them to be part of this legislation; we think it is very important. We are funding a lot of what is in our bill through our ANWR provisions.

We take half the money from ANWR lease sales and devote it to these conservation, renewable, and alternative fuel proposals included in S. 341. I might say that we have an advanced nuclear reactor section in our bill, but I think in view of testimony we have heard, we will probably take much of that out. I think it may be premature to do a technology demonstration of the next generation of reactors.

Coal is certainly a favorite of this committee, but it has also been funded under the clean coal program. I would think we would want to put some limitation on additional funding in this bill, but we would want to get it generously funded. For one thing, we do not want those who are most interested in conservation initiatives to be concerned that we are going to use all the money for other things. We want to be sure we have the money from the ANWR lease sales. I know you have been interested in this clean coal technology. I hope you will join with us, and the administration will join with us enthusiastically to try to make all of this happen.

I think clean coal will make a stronger bill. I think when you really try for energy security, then clean coal makes a tremendous amount of sense. We have made some great progress on that, and we really want it part of this bill. If I can just talk Senator Ford into the fact that coal is important to the country, we can make sure it is part of this bill.

[Laughter.]

Senator FORD. Senator, I have listened to your eloquent words. I am convinced that I am at the top of your list, when I hear the same type of statement as it relates to uranium enrichment, and then we get to coal, I understand.

The CHAIRMAN. We have got uranium enrichment right here at the top.

Senator FORD. We want this to be an integral part. We wanted to be an integral part.

Senator JOHNSTON. If I could just make my quick little two-bit speech here. I have been in this committee now for 18 years. I have seen three energy crises come and go. In a sense we are still in our third, it is called Desert Storm.

It is time for the country, and it is time for this committee, it is time for this Congress to do something about it. We have got a program here in our bill that covers the waterfront. It may not be that every single provision of it has got to survive in order to make a bill, but I can tell you that the Congress cannot start taking off major pieces of it, and expect the legislation to survive.

I mean, you have got to have production, you have got to have things like coal on the producing side in order to balance out the conservation side, and I believe in both of those sides of the equation. We have got, I think, an historic opportunity to get this legislation out. It ought to include clean coal, and I believe coming out of this committee it will include clean coal. I believe on the Senate floor we can keep clean coal in it, and I hope the administration and you will put it at the top of your priorities, because it is at the top of our priorities.

Thank you, Mr. Chairman.

Senator FORD. Thank you, Mr. Chairman.

Senator Wallop.

Senator WALLOP. Thank you, Mr. Chairman. I will be brief, but I have a problem that echoes that expressed by Senator Ford, in that I do not think that the administration has put as much effort into clean coal technologies as they ought to have. Nor has it been as balanced as I would have hoped.

But the thing that bothers me even more, even though we have got a very good liquids program, the ENCOAL project in Gillette under way, is that your focus seems to be almost exclusively on the liquid uses and not the dry uses of coal and the nonfuel uses of coal. But both of those things are part and parcel of an energy strategy. If you are going to be able to free up oil for some of its more valued uses other than just as a fuel, namely as chemicals, then you are going to have to do the same thing for coal.

I just do not see the dry side of clean coal having anything like as much emphasis in your minds as the liquids. Am I wrong?

Mr. GENTILE. I am not certain, Senator. If we look at the clean coal program, three projects come to mind that really have to do with nonfuel use. One is ENCOAL in Wyoming. There are two with Bethlehem Steel.

Senator WALLOP. ENCOAL is not a nonfuel use.

Mr. GENTILE. No, I am sorry, but it can be geared towards a slate of solid or liquid fuels. I am sorry. Or it could be feed stock. It could be a variety of products. In other words, that is how I characterize it.

Senator WALLOP. They believe and I believe that, yes there is a benefit, and that your principal purpose was funding liquid fuels. They also will produce a dry, highly clean fuel out of it.

Mr. GENTILE. And I also think the project in Montana with Western Energy, if I recall, that project takes a coal product that is about 5,000 to 8,000 BTU's and about 25 percent to 50 percent moisture, and basically dries it to a less than 1 percent moisture at 12,000 BTU product. So that is definitely a dry fuel product.

We also have a project in Alaska, that is also doing the drying? Well the ideal is to dry some of the water out of the coal.

Mr. SIEGEL. Yes, sir. In our R&D program in the fiscal year 1992 budget, we do have a continuation of a project at Western Research Institute, to look at advanced techniques of drying of coals. There is some emphasis in the program on that.

Senator WALLOP. What about the nonfuel uses?

Mr. SIEGEL. We have a variety of projects in that area as well. The mild gasification program continues on as part of our liquefaction program, although it is geared in large part towards transportation fuels.

Senator WALLOP. But those are fuels projects. I am talking about the nonfuel uses of coal as chemicals.

Mr. **Siegel**. There are two on the coking side, two projects on the coking side. One is a direct coal-to-steel, which bypasses the coking process, and the other is, again, with Bethlehem Steel, and it is a coke oven gas cleanup.

Those are the only two I can think of on the dry side, but even in our liquids program—technology being developed under the liquids program, can produce a slate of products some of which could be for fuel applications and others for nonfuel, for chemicals and the like.

Senator **Wallop**. Well, I guess, inadvertently you have answered my question; you have struggled so hard to find some nonfuel uses of coal in liquid things that really the answer is you ought to be doing more.

At least that would be an answer that I think Senator Ford and I would agree upon. I have an awful feeling that the Department of Energy is weak in asserting its ideas and views with regards to the Environmental Protection Agency. The questions that he asked about the regulatory inhibitions to the uses of coal really did not get an answer. You know the answers, and I know them, and they ought to be out in public. I do not know why the hell you do not say so, except that maybe Mr. Reilly has more sway with the administration than does Admiral Watkins.

I certainly hope that is not the case, because one of the things that is happening as we use other people's fuel from around the world is that we are allowing them to degrade their environment, as though we do not care how we do it in their part of the world, though we share only one thing and that is the environment.

So for us to lay off our energy needs on the Third World, or other parts of the world, while seeking to avoid consequences to our own environment, is both short sighted and a bit mean spirited.

Mr. **Gentile**. I wholeheartedly would agree with you, Senator. It is not just an issue of solving our technology and fuel use problems in the United States. If we cannot solve them elsewhere, we are not going to accomplish anything.

Senator **Wallop**. Mr. Chairman, we have another panel, yet, but I would like to just explore for half a minute the WEPCo thing.

I guess the most important thing that you could say out loud and in public is what effect the WEPCo decision has had on the conduct of the clean coal project.

Mr. **Gentile**. As you know there has been a fix in some of the clean coal demonstration projects, namely those that are temporary and those that are permanent re-powering. What remains to be fixed are the permanent retrofit clean coal technologies.

I believe there was a hearing yesterday with Dr. Schmalensee. I think that Dr. Schmalensee then said that there would be an interpretative ruling out, perhaps in June, that would deal with some of these issues. A proposed rule would also be involved to fix up some of the other technologies.

Senator **Wallop**. But the basis of my question is still that we are having a hard time getting to the central points. One is, what effect does it have? The second is, and I know Dr. Schmalensee said that the administration was working on their efforts to finalize their position, that while they are working to finalize a position, everybody else's position is on hold. Nobody knows which way to go.

Mr. GENTILE. Absolutely, and it is a problem. It is a problem that is affecting some of the clean coal technologies, it is affecting utilities' decisions. The Admiral has clearly made it a very important priority. He has worked this WEPCo issue very hard. It has been one of his number one issues. It is also in the NES, because he knows it is a number one issue.

It is impacting things at this point, and we would hope it is remedied very quickly.

Senator WALLOP. You cannot speak for the Admiral in this thing, but let me ask you this. What can this committee do besides ask these questions in public to persuade the administration that it is time to finalize their posture on this thing?

Everybody in America that has anything to do with these projects has every decision that they could possibly make on hold while we wait for you. And not only is it frustrating to us politically, but it is awfully expensive for people just to sit around with their investments, waiting for the administration to make up its mind how it is going to react. What can we do?

Mr. GENTILE. I do not know the answer to that, Senator. I will most certainly bring this back to the Admiral today, and let him know of your concern and how important this committee thinks this is, and ask the Admiral if there is any other approach that we can take to move this quicker.

Senator WALLOP. Well, I would appreciate that.

Mr. Chairman, that would conclude my questions. But I just have got to tell you that the one thing that frustrates the private sector of America more than anything else, is not a red light that says, no you cannot do it. They all want the green light, or they would not be asking in the first place.

But it is this damn flashing yellow. It just says, wait, we will figure it out. Just hold onto your money. It does not mean anything that it is not invested, or it does not mean anything that it is invested up to a point that it cannot do anything else, and it just needs an answer.

So, you know, give us a red or give us a green. Hopefully give us a green, but let us as a country move. That is what is really hurting us

Thank you, Mr. Chairman.

Senator FORD. Thank you, Senator Wallop. I think that is all, Mr. Secretary. We will have some questions for you in writing, and hope that you will answer those in a timely manner.

Mr. GENTILE. Thank you, Mr. Chairman.

Senator FORD. Next will be William Carr, president of the mining division, Jim Walter Resources, also chairman of the National Coal Council.

We are glad you are here, Mr. Carr, and if you want to submit your statement for the record and highlight it, however you wish to do it, I will be glad to accommodate you.

STATEMENT OF WILLIAM CARR, PRESIDENT, MINING DIVISION, JIM WALTER RESOURCES, AND CHAIRMAN, NATIONAL COAL COUNCIL, ACCOMPANIED BY LARRY GRIMES, GENERAL COUNSEL, NATIONAL COAL COUNCIL

Mr. **Carr.** Thank you, Mr. Chairman.

Chairman Ford and Member of the subcommittee. My name is William Carr. I am president of Jim Walter Resources, Mining Division, in Birmingham, Alabama. I am also chairman of the National Coal Council.

Also with me today is Mr. Larry Grimes, the general counsel for the NCC, and I appreciate the opportunity to address the subcommittee today.

I have submitted for the record a copy of the full text of my remarks, together with a copy of the council's recent study on the national energy strategy.* I would, however, Mr. Chairman, like to make just a few brief remarks.

Mr. Chairman, the National Coal Council is a private, non-profit group of business leaders drawn from many different industries across the United States. We are chartered under the Federal Advisory Committee Act to give ongoing advice and guidance to the United States Secretary of Energy. All members of the council are appointed by the Secretary. We fulfill our charter by conducting studies, and presenting the results of these studies and reports to the Secretary.

We are strictly advisory, and are forbidden from any lobbying type activities whatsoever. We are not affiliated with nor tied to any trade association. Mr. Chairman, the National Coal Council has repeatedly advocated a strong national energy strategy to set a course to help this Nation meet its ongoing and increasing energy needs.

A strong, viable energy policy must, however, balance all of the energy resources that exist within our borders. In its role as an advisor to the Secretary of Energy we have consistently stated that coal is our most abundant energy resource. Increased reliance on domestic production can and will decrease U.S. dependence on foreign energy from unreliable sources. Mr. Chairman, you yourself have stressed this.

We have most recently contributed advice and information to the Secretary relative to the coal industry's place and importance in a national energy strategy.

A few facts: on an energy equivalent basis, U.S. coal reserves are 43 percent greater than the world's combined known oil and gas reserves. This vast resource amounts to 95 percent of all proven native fossil fuel reserves. At this point in time, 57 percent of the electricity generated in this country comes from coal. More than half the lights burning in this room use coal-generated electricity. This is the equivalent of approximately 560 million barrels of oil on a yearly basis.

A successful energy strategy must—and I paraphrase our recent report here—first insure a dependable, stable energy supply, continue the protection of our environment, based on sound scientific principles, must strengthen the U.S. economy by promoting the use of domestic energy resources and technology, both at home and abroad. It must also promote worldwide economic development by encouraging the development and deployment of environmentally sound coal-based energy technology, such as those promoted by the clean coal technology program to developing nations.

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* The study has been retained in committee files.

In the National Coal Council's opinion, a national energy strategy that ignores coal ignores an energy source that is abundant within our borders, and which can be used extensively to meet each of the listed objectives that I have just gone through. Ignoring coal would also increase dramatically the amount of energy that this country has to import. It is the National Coal Council's opinion that no national energy strategy can be considered realistic nor feasible if it does not allocate a major role to coal.

The program of clean coal technologies presently being implemented by the Department of Energy and industry is essential if the vast coal resources of the United States are to be utilized for the maximum overall benefit in an environmentally sound manner. Clean coal technologies address the problems of sulfur dioxide, carbon dioxide and nitrous oxide emissions. These technologies are designed to increase the efficient use of coal and maximize its contribution to the Nation's future needs.

In almost every one of the studies conducted by the council, we have emphasized the belief of the council that every effort must be made to continue and accelerate the development and deployment of clean coal technologies. In addition to this need being discussed in nearly all of our studies, two studies—Clean Coal Technology and Innovative Clean Coal Technology Deployment—specifically addressed these issues.

In summary, Mr. Chairman, the major challenge in the future of coal is the development of a political and economic climate which provides incentives for the use of indigenous energy resources in order to limit energy imports and to attract investment capital for the coal industry.

Drastic environmental policies, particularly those lacking adequate scientific support, coupled with a lack of nationwide resolve to develop, demonstrate, and deploy economically-competitive clean coal technologies are among those factors which could contribute to an unfavorable investment climate and thus chill the development of this country's major indigenous resources.

The recommendations made in the National Coal Council's study entitled The Long-Range Role of Coal in the Future Energy Strategy of the United States seemed to cover a wide and divergent range of topics. But taken together, Mr. Chairman, all of the recommendations do center on a common theme. Any national energy strategy should ensure that developing technologies to given time to be deployed and not be sacrificed to quick fixes or short-term benefits that are outweighed both by the lost long-term benefits and an increased economic cost.

In the last 10 years, U.S. coal has made substantial progress, gaining a strong position in the United States and world energy markets by increasing productivity some 85 percent, whilst at the same time, improving its environmental and safety record. For example, coal production has doubled during a period in which SO_2

emissions have been cut by some 30 percent. Coal mine fatalities in U.S. mining operations have been cut in half in the last 10 years.

Developing technologies, Mr. Chairman, will assist the industry to outshine these accomplishments in the coming decades. But for those technologies to achieve this goal, they must be encouraged to be developed and be allowed to be deployed. And as a result, such developments and their benefits will continue to improve the lifestyle and well-being of this country's and the world's peoples so long as we do not sacrifice this potential on the altar of quick fixes based on political expediency.

The National Coal Council reaffirms the strong belief that domestic coal can, should, and must play a major role in the long-range national energy strategy. Anything less will be a disservice to the United States and its people.

I would like, Mr. Chairman, to take this opportunity to congratulate the sponsors of this legislation for their recognition of the importance of coal to the future of this Nation. Such recognition, if and when implemented, will undoubtedly go a long way towards ensuring the future viability of the coal industry and, by so doing, will substantially underpin the continued availability of energy to meet the Nation's needs in the future.

Mr. Chairman, this concludes my remarks. I would be pleased to respond to any questions you may have.

[The prepared statement of Mr. Carr follows:]

National Coal Council
Testimony Before
The Senate Committee on Energy and Natural Resources
Subcommittee on Energy Research and Development
March 19, 1991

The National Coal Council has repeatedly advocated a strong National Energy Strategy to set a course to help this nation meet its ongoing--and increasing--energy needs. A strong viable energy policy must balance all of the energy resources that exist within our borders.

In its role as an advisor to the Secretary of Energy, the Council has stressed repeatedly that coal is our most abundant energy resource. Increased reliance on domestic coal can and will decrease U.S. dependence on foreign energy from unreliable sources.

A successful energy strategy must:

--ensure a dependable, stable energy supply,

--continue the protection of our environment based on sound scientific principles,

--strengthen the U.S. economy by promoting the use of domestic energy resources and technology both at home and abroad, and

--promote world-wide economic development by encouraging the development and deployment of environmentally sound coal-based energy technology (such as those promoted by the Clean Coal Technology Program) to developing nations.

A National Energy Strategy that ignores coal ignores an energy source that is abundant within our borders and can be used extensively to meet each of the listed objectives. Ignoring coal would also increase dramatically the amount of energy this country imports. It is the National Coal Council's opinion that no National Energy Strategy can be considered realistic if it does not allocate a major role to coal.

BACKGROUND

Chartered under the Federal Advisory Committee Act, the National Coal Council's mission is advisory only, providing guidance and recommendations as requested by the Secretary of Energy on general policy matters relating to coal. The Council receives no funds or financial assistance from the federal government. It relies solely on the voluntary contributions of the members for the support of its activities.

On January 19, 1989, then Secretary of Energy John S. Herrington asked the National Coal Council to prepare a report studying coal and its place in America's energy future. Later that year, Admiral James D. Watkins reaffirmed the need for such a report.

The request was answered in July of 1990, when the Council presented "The Long-Range Role of Coal in the Future Energy Strategy of the United States."

"The Long-Range Role of Coal in the Future Energy Strategy of the United States"

The formulation of a National Energy Strategy cannot effectively be done in a vacuum. Economic, environmental, and political factors must be taken into consideration if a usable strategy is to be developed.

With this in mind, the National Coal Council's report "The Long-Range Role of Coal in the Future Energy Strategy of the United States" used three scenarios to evaluate the potential role of coal in the next 60 years. These scenarios are diverse enough to provide for a broad range of factors which could logically be expected to occur during that time period.

Each scenario describes different national and international environments, GNP growth rates, and energy growth rates. The first scenario was characterized by reasonably coherent global, economic, and political conditions over the time frame with a balanced response to economic and environmental tradeoffs in the United States, coupled with dynamic technological development.

The second scenario presented a somewhat less hospitable world. In this scenario, the global, economic and political conditions were, volatile. Thus whilst the United States' economic and energy tradeoffs were generally balanced, only incremental technological progress was realized during this time frame.

The third scenario is set against similarly volatile global, economic, and political conditions but with a very erratic situation in the United States as competing interests force frequent and dramatic policy swings on economic and environmental issues. Coupled with only incremental progress in technology, this last scenario presents the most difficult energy climate for the world.

The range of futures presented by the three scenarios underscored several general conclusions common to all. They are:

- Ample economic energy supplies are critical to societal stability and progress.

- Because of the large, cost-competitive resource base, coal must be a major component of the nation's future energy base.

- To remain economically competitive and to preserve the current high level of living standards, it is imperative that the United States resolve conflicts between energy and environmental priorities in a cost-effective manner, based on long-term objectives.

- Technological advances have, and will continue to, significantly affect coal's future in the areas of utilization, production and transportation. Aggressive programs which develop, demonstrate and deploy environmentally sound and cost-effective Clean Coal Technologies will provide huge benefits to the population of America and the world. Legislative and regulatory quick fixes that sacrifice these programs for short-term benefits will have long-term detrimental affects.

- A political and economic climate must be fostered which provides incentives for the use of domestic energy sources. This will serve to both limit imports and attract investment capital to all facets of the American energy industry.

- Multiple scenarios leading to flexible strategy options are crucial for the maintenance and viability of any energy policy.

- Restraining coal use will lead to increased dependence on imported energy under any combination of factors.

These rather general conclusions led to very specific recommendations to the Secretary of Energy as he and the Department of Energy formulated the National Energy Strategy. The National Coal Council feels these recommendations should be reiterated as the Senate Energy Committee and Congress consider the future energy security of this nation.

Recommendation #1: The Secretary of Energy should ensure that the National Energy Strategy acknowledges the importance of coal in the nation's energy and economic future.

This would serve to acknowledge this vast resource within our own borders. America's coal reserves constitute almost 95 percent of proven native fossil fuel energy reserves. On an energy equivalent basis, demonstrated coal reserves in the United States are 43 percent greater than the *world's* combined known oil and natural gas reserves. Additionally, America's coal reserves account for 35 percent of the world's proven recoverable coal.

At present, approximately 57 percent of electricity generated is produced from coal. In general terms this equates to an annual off-set of 556.2 million barrels of oil or 3.1 trillion standard cubic feet of natural gas.

What these figures show is that coal will--and must--play a major, vital role in any future energy strategy. This fact is apparently not readily accepted or promoted.

But, it is vital for the future stability of coal use in America that coal be mentioned prominently. Such a reaffirmation of its role will dispel attempts to curtail its use. This, in turn, will assure the continuation of capital investment in all aspects of the industry.

Recommendation #2: The Secretary of Energy should expedite the completion and deployment of selected Clean Coal Technology projects, and in the future should direct the program toward new technologies which promise to yield higher energy conversion efficiencies and lower environmental impacts.

The key to full utilization of this nation's coal resources is the Clean Coal Technology program. Through the CCT program, coal can be used most effectively to meet energy, environmental and societal goals.

Among the mechanisms the Secretary should employ to foster this program are (1) establish legal precedent to allow for modernization of existing electric generation capacity and industrial steam boilers such that new source performance standards are not immediately triggered; (2) encourage reliance upon indigenous energy resources to limit energy imports to acceptable levels; (3) encourage public utility commissions to evaluate fuel economics over the expected life of electric generation facilities; and (4) minimize disincentives to the use of clean coal technologies imposed by the recently passed Clean Air Act amendments.

In the worldwide market, coal will compete with other fossil fuel sources to meet the needs not only of this nation, but also of other nations. Where coal is the fuel of choice, the great resources of the United States will become more valuable. For this reason, and because energy costs play such a significant role in the United

States economy, it is vital to the national interest to continue a vigorous program to improve the economic and environmental acceptability of coal.

Recommendation #3: The Secretary of Energy should exert leadership in the formulation of national and international scientific studies which lead to better understanding of environmental issues relating to energy use.

The Department of Energy must be actively involved in national and international bodies concerned with global environmental issues to ensure that sufficient scientific justification exists for drastic environmental measures that affect the National Energy Strategy.

Currently, there some calls for the curtailment of coal use which cannot be substantiated by adequate scientific analysis. These concern such controversial issues as global warming and acid rain. The rush to spend this nation's national treasury on such as yet vaguely delineated issues should be resisted. This country cannot afford bills that run into the billions of dollars to make changes that may ultimately prove to have little affect on our environment. For instance, even if we eliminated all of the coal-fired power plants in the United States (and 57 percent of our electrical capacity) the annual global CO_2 emissions would only be reduced three percent.

Recommendation #4: The Secretary of Energy should ensure that the National Energy Strategy calls for national and international policies which foster improved energy efficiencies.

Leaders here and abroad should be encouraged and supported in their efforts to foster and promote energy efficiency improvements.

Lesser-developed countries (LDCs) should especially be assisted in importing efficient technologies that would enable them to effectively use their indigenous energy resources. This would reduce environmental impacts and improve the prospects for economic expansion in these countries.

It is estimated that Pacific Rim nations alone will install 49,000 megawatts of new electric generation capacity in this decade. These investments will define long-term commitments to coal or alternative fuels over most of the first half of the next century. Thus, decisions made in the next 10 years will affect coal and coal technology export opportunities for many years to come.

Recommendation #5: The Secretary of Energy should develop a program by

which the economic risks associated with large-scale facilities based on coal can be mitigated so that commercial deployment of clean coal-based technologies can take place.

Current coal production and utilization of over one billion tons per year is testimony to coal's importance. New technologies will permit coal's contribution to be extended and its current position to be reinforced. The Secretary of Energy is therefore encouraged to seek mechanisms such as tax credits, accelerated capital depreciation, "first-of-a-kind" risk protection relative to costs imposed by accelerated environmental compliance schedules, etc., so that the risks of commercial deployment can be made more acceptable. This will allow newly-developed technologies to be available when required.

The Secretary must work closely with other members of the Cabinet, Congress, state and local government agencies, including utility commissions, to assure that short-term investment in coal-based industrial and electric generation facilities takes place.

Recommendation #6: **The Secretary of Energy should ensure that the National Energy Strategy promotes the development and demonstration of technologies for producing coal-derived liquids and gases.**

Technologies have rendered coal the most versatile of fossil fuels. Technologies to convert coals to liquids and gases must be at the core of the nation's energy strategy in order to (1) cap the upper limits on imported oil and gas prices, and (2) create the potential to increase domestic supplies of liquid and gaseous fuel as much as may be necessary to meet national demand and protect economic and national security.

Potentially competitive technologies are in various stages of research and development in the United States and abroad, but none of these can lower the cost of coal-derived liquid and gaseous fuels to current market levels. However, any significant reduction in these costs should be worthy of demonstration.

But, an important hurdle remains. To meet the needs of an economy the size of the United States, significant productive capacity will be required. The design, construction and startup of the type of facility described above is a process requiring as long as ten years. The price and availability of existing energy supplies respond to much shorter time frames. Thus, providing a mechanism by which the risks of commercial coal-derived fuel deployment can be made more acceptable must be a priority for the Department of Energy.

Recommendation #7: The Secretary of Energy should ensure that the National Energy Strategy facilitates the efficient utilization of the existing coal transportation infrastructure, and recommends federal eminent domain powers to secure adequate rights-of-way for the transport of coal over the next fifty years. Additionally, the Secretary must work to ensure that electric utilities are able to develop the transportation networks necessary to efficiently move power from the most economic sources as recommended in the Council's June 1986 report, entitled "Interstate Transmission of Electricity."

Mechanisms to resolve right-of-way issues in a timely manner will enhance the efficient development of domestic coal resources and the deployment of innovative transport technologies such as coal slurry pipelines.

Also, the Department of Energy should work with state public utility commissions to assure adequate and proper distribution of electricity within and among states and regions in the United States.

Recommendation #8: The Secretary of Energy should assure the development and deployment of a comprehensive worldwide energy forecast modeling capability.

The National Energy Strategy, by law, must be reviewed biennially. In order to adequately judge the effectiveness of the strategy, improved modeling capabilities must be made available. This capability must be global in scope. The interrelationship between all nations in the field of energy is inescapable.

Our scenario analysis clearly showed the negative consequences caused by sudden changes in economic and political conditions over the long-term. In order for the National Energy Strategy to be sufficiently robust to stand up to the test of time, the Secretary needs to have in place modelling tools that allow the testing of a wide array of potential future outcomes, and avoid dependence on single-line energy forecasts.

Recommendation #9: The Secretary of Energy should work with the Secretaries of the Interior and Labor, and the Administrator of the Environmental Protection Agency to: seek balanced, economic solutions to future mining-related environmental issues and more flexibility in bringing innovative solutions for mine safety to the work place; assure timely availability of federally-controlled coal reserves to private enterprise; and promote future mining technology development.

The National Coal Council recognizes that future environmental and safety concerns will need to be addressed by both government and the industry. However, to efficiently progress to beyond the billion ton level of output, the coal mining industry must strive for solutions that achieve the desired environmental and safety results while improving the economic competitiveness of the industry.

CONCLUSION

In summary, the major challenge facing the future of coal is the development of a political and economic climate which provides incentives for the use of indigenous energy resources in order to limit energy imports and to attract investment capital for coal. Drastic environmental policies, particularly those lacking adequate scientific support, coupled with a lack of nationwide resolve to develop, demonstrate and deploy economically competitive Clean Coal Technologies are among those factors which could contribute to an unfavorable investment climate.

The recommendations made in "The Long-Range Role of Coal in the Future Energy Strategy of the United States" seem to cover a wide and divergent range of topics. But, taken holistically, all of the recommendations do center on a common theme: any National Energy Strategy should ensure that developing technologies be given time to be deployed and not be sacrificed to "quick fixes" or short-term benefits that are outweighed by both the lost long-term benefits and economic costs.

In the last ten years, United States coal has made substantial progress in gaining a strong position in the United States and world energy markets by increasing productivity 85 percent while simultaneously improving its environmental and safety record.

Developing technologies may have the ability to outshine these accomplishments in the coming decades. But, for those technologies to achieve this, they must be encouraged to be developed and allowed to be deployed. Such developments and their benefits will continue to accrue to the life and well-being of the world's population as long as legislators and regulators do not lose sight of the long-range goals and scenarios.

The National Coal Council reaffirms its strong belief that domestic coal can, should and must play a major role in a long-range National Energy Strategy. Anything less will be a disservice to the United States and its people.

Thank you.

Senator FORD. Thank you very much, Mr. Carr.

The National Coal Council has made many recommendations in these areas and has worked to make them come about. I just wondered if there is a way you could briefly outline now for the edification of the committee those past recommendations that you have made for us. It would be, I think, interesting for us to see the recommendations, what has transpired and what has fallen by the wayside, and kind of get a synopsis of your recommendations and what we feel like might be necessary in the arena.

Mr. CARR. Yes, sir. We would be most happy to do this, and we will submit those in writing to you.

Senator FORD. You are mighty nice to accommodate us, Mr. Carr. In your past reports that we refer to, you stated consistently the need to accelerate the development of clean coal technologies. Some people have said that it is just a question of spending more money more quickly in the arena. Try to draw me a difference between just spending more money more quickly and trying to get a process that would be developed for the betterment of this country as it relates to energy strategy.

Mr. CARR. Yes, sir. We certainly addressed this question of deployment of the clean coal technologies in one of our reports to the Secretary. We listed a number of complex and complicated recommendations. Again, I think rather than repeat them here, although I can do that, I would be prepared to submit them in writing to the committee.

Senator FORD. That would be perfectly all right, Mr. Carr.

Mr. CARR. Okay.

Senator FORD. Would those actions that you have recommended require legislation?

Mr. CARR. Some of them would, Mr. Chairman. Others, I think, are some roadblocks that can be cleared with some political clout and perhaps some exercise of leverage from the various parties involved.

Senator FORD. It could be done administratively, then, rather than legislatively.

Mr. CARR. I think some can, although some would require some legislative action, too.

Senator FORD. Do you believe there is anything to be gained by waiting for the results of round one through four before proceeding with round five solicitation?

Mr. CARR. Mr. Chairman, we have consistently advocated that this program should be pushed as hard as it possibly can be. From my remarks briefly made this afternoon, I think it is obvious from our point of view in the National Coal Council that we see the future of coal very strongly tied to the deployment of these technologies.

Now, we do recognize that some require certain acts to be done in the first rounds before the second, third, and fourth rounds can be accomplished, but there are others that we do and have indicated can be carried on and can be put into practice and put into effect.

Senator FORD. Was this part of your recommendations?

Mr. CARR. This was part of our recommendations, sir.

Senator FORD. You stated in your abbreviated statement that clean coal technologies will play, of course, a significant part in efforts to decrease our dependency on foreign supply. Now, I had some figures here—is it 560 million barrels that would be displaced a year——

Mr. CARR. That is correct.

Senator FORD [continuing]. By the use of coal? What technologies are you talking about using? How did you arrive at the 560 million barrels of oil per year?

Mr. CARR. This was in reference to the amount of coal being used to generate electricity currently in this country——

Senator FORD. Yes, sir.

Mr. CARR [continuing]. And transferring that on an energy-equivalent basis into oil?

What, in fact, we were saying, Mr. Chairman, was that if we did not use coal to generate 50 percent of our electricity, we would, if we were importing oil, have to import 560 million barrels of it on an annual basis. So it really was not relevant to the clean coal technology program.

Senator FORD. Oh, all right. But if we would move into that area of clean coal technologies and use, as I refer to, a "home-grown" resource, what kind of prospects do we have for replacing foreign oil or displacement of imports?

Mr. CARR. Mr. Chairman, that is part of our reports to you. I have not got the figures in front of me directly, but certainly we can supply you with those.

Senator FORD. I think that is important, because that is one of the items that the Senator from Wyoming just asked a few moments ago of the administration's witness.

Should the Department of Energy be increasing emphasis on liquid fuel developed through clean coal technologies, or should they be pushing all categories of new technologies and try to keep them on track?

Mr. CARR. We have referred to this in one of our studies on transportation, Mr. Chairman. I think it is a difficult one to answer. The question of time frames come into it. From the point of view of the next maybe 5, 10 years, time frames are maybe on the dry side, if I can take the Senator's point that he made earlier. And maybe in the longer term, the applicability of liquid fuels will be more in the field.

However, I would qualify that only by saying that we have recommended in our studies also, the active pursuit currently by the Department of Energy of coal-water slurries. Now, this is a means of using extremely fine coals suspended in water to directly replace diesel oil and diesel fuel oils. This, we think, is an area than can be pushed.

A lot of work is being done currently and, if I can put my hat on as an operator, something that we are doing in our own shop in Alabama to make a liquid fuel from coal that can sustain a burn both in a power station situation and in other fuel-burning situations.

Senator FORD. We may have touched on this a little bit, but you have a study under way on the future role of coal in the near term, and I would assume this will focus a lot on the deployment and commercialization of clean coal technologies; is that correct?

Mr. **Carr**. That certainly will be part of the study, Mr. Chairman.

Senator **Ford**. Are you looking at whether clean coal technologies will be ready to meet the new requirements of the Clean Air Act?

Mr. **Carr**. We have not specifically addressed that and, again, any of my remarks, of course, I have to qualify to the extent that the Secretary of Energy does indicate the areas which we are to study, and until he asks us to get into a particular area, then we do not necessarily have a cohesive opinion on that particular area.

Senator **Ford**. Is it out of the realm of your assignment for you to make your own judgment on what to study and what to report to the Secretary?

Mr. **Carr**. Mr. Chairman, it operates very much on a two-way process. We talked to the Secretary and his people about what we think ought to be a particular study, and we have a to'ing and fro'ing on the matter until we focus on a particular subject matter. This is the way it has worked in the past.

Senator **Ford**. Do you win or lose?

Mr. **Carr**. We win more than our fair share.

Senator **Ford**. Senator Wallop.

Senator **Wallop**. Thank you, Mr. Chairman. We have not had another full panel yet, and I think you have covered the ground with Mr. Carr. It does strike me that as I try to elicit the information from Mr. Gentile that we are tempered, I guess is the best word. It is not that we do not have a program for clean coal or nonfuel uses of coal; we just do not have what I would call a robust one.

The continued aggressive presence of the Council is needed to prod us, the administration, everybody to keep going in areas that are plausible. That is the focus of your existence. Sometimes ours gets diffused. I just urge you to try hard to keep some focus on these areas, and where greater effort is needed. Do not let it be because you were silent that it happened.

As I look around it is clear to me that the Soviet Union is probably now an importer of oil, although they say different. They certainly are no longer an exporter of consequence. The merging democracies of eastern Europe are going to be much more oil dependent than they have been simply because they have so fowled their environments that their ability to use coal with their current technologies is highly limited.

That necessarily reverts to a strain on price and availability of oil for Americans. And when we have this abundant resource, it seems to me that it is a tax we need not pay, if we could just get on with it and give ourselves the flexibility of doing something else, lessening Eastern Europe's burden and the rest of the world's burden, as well as own. I approve of your role and I want you to be aggressive with it.

Mr. **Carr**. We will be as aggressive as we can, Senator.

Senator **Ford**. Senator Burns.

Senator **Burns**. I have no questions. Thank you very much.

Senator FORD. Mr. Carr, it is nice to have you and we appreciate your appearance, and we look forward to working very closely with you.

Mr. CARR. Thank you, Mr. Chairman.

Senator FORD. Since the hour is moving on, I hope the next four people would not mind sitting in as a panel. Mr. Katlic, chairman of the National Coal Association; Ben Yamagata, Clean Coal Technology Coalition; Kurt Yeager, vice president, technical operations, Electric Power Research; and Paul J. LaHaye, chairman of Hague International.

If you gentlemen will come forward, we want to hear your testimony, but we—we have lucked out so far. We have not had to leave for a vote, and I have been keeping my fingers crossed.

Mr. Katlic, if you want to proceed that will be fine.

STATEMENT OF JACK E. KATLIC, SENIOR VICE PRESIDENT, AMERICAN ELECTRIC POWER SERVICE CORP., ON BEHALF OF THE NATIONAL COAL ASSOCIATION

Mr. KATLIC. I am senior vice president of American Electric Power, and chairman of the National Coal Association. I want to say that it is refreshing to have someone trying to find a role for coal, and it is a pleasure. We have been in a lot of things up here, but this is the most refreshing one I have been in for a long time.

Mr. Chairman, I commend your support. I will move through my presentation rather promptly. Being at this position in the day, many of the words have been stated already. We are going to have to make some hard decisions, and those decisions—none of them can succeed on energy without coal. So I want to say that many of S. 341's proposals will advance the Nation along the path to energy security. It is compatible with economic growth, protection of the environment, and NCA supports the purposes of S. 341 in those aspects of the legislation as they relate to coal.

I am going to specifically talk about several of the provisions in title V. You have mentioned many key points today, and the key is going to be that coal will be used as a base-load fuel to generate electricity. In the United States, coal consumption for generations, as you have heard earlier, is not only expected to increase from today's 770 million tons, but it will approach 1.3 billion tons by the year 2030. Capacity to burn this coal will increase accordingly.

I might insert a little personal statement to the chagrin of the NCA staff. If coal had a fault, it has been its success, Senator. It has always met whatever the market would take and always done it with improved cost, productivity, and its attention to the laws. So if coal has a flaw, it is its own success in always doing whatever it has had to do, without many people helping it.

So on coal, coal technology, and electricity, title V of S. 341, we would need to look beyond our borders by recognizing the essential role of U.S. coal and U.S. coal technologies in meeting the growing energy needs of not only our economy, but to developing economies throughout the world. section 5001 directs the establishment of R&D demonstration program for advanced coal-based technologies. It will result in a new generation of technologies, and it should be patterned after the highly successful industry government clean coal tech program.

They have to begin now if they are going to be commercially available in the next century. We support the focus of developing advanced coal-based technologies with even greater efficiencies and lower emission rates, again following the current CCT program for a wide menu of technologies. As you have already discussed—and we would be remiss if we did not mention our disappointment and concern with the administration's proposal to redirect funds already appropriated for round five of the current clean coal program.

We urge the committee, Mr. Chairman, to oppose any reprogramming request submitted to the Congress. Section 5002 directs development of a plan for RD&D of nonfuel uses, another subject that was mentioned here earlier. This plan should serve as a blueprint to identify opportunities, priorities for research that will result in commercialization of technology for nonfuel uses of coal.

We would make two suggestions regarding this research program. One, the Secretary be directed to establish an advisory committee comprised of representatives of manufacturing or other industries that are current or potential nonfuel users of coal, representative of the coal industry, and representatives of other relevant government agencies such as the EPA, the Department of Commerce to assist the Department of Energy; and two, that the plan include a survey of the technology and research programs for nonfuel uses of coal in other developed countries.

Sections 5003 and 5004 address the role that U.S. coal and U.S. coal technologies can play in foreign markets. The world market for coal is closely linked with the deployment of clean coal technology, and we like this linkage. We suggest that these two sections be combined and that the reports required in each cover both coal and coal technologies. The advisory council would direct this integrated effort.

We are encouraged to note that S. 341 specifically directs the export advisory council to address the financial barriers that prevent U.S. manufacturers and exporters from expanded participation in overseas markets, especially in the developing world. There is a clear role for the United States Government in meeting these forms of competition.

NCA fully supports the establishment of programs to facilitate access to capital and credit for financing clean coal tech projects and coal in foreign markets. More specifically, loan programs should require that a certain percentage of the coal burned in the financed facilities be from the United States. Such "tied aid" is prevalent throughout the world, with the exception of the United States, and should now be seriously considered by the administration and the Congress. It would be counterproductive for the United States Government to finance a U.S. clean coal tech project abroad so that the project could burn coal imported from another country.

Section 5005, Coal, Coal-Water, Coal-Oil Mixtures, near-term opportunities for coal to replace imported oil in utility and industrial applications. Because of the direct substitution, this effort offers significant potential oil displacement. Section 5006 addresses one aspect of coal as a transportation fuel use. Commercial demonstration of coal-fired diesel engines capable of competing on a cost-effective basis with conventional diesel would reduce dependence on petroleum imports.

Section 5101—and NCA supports strongly the efforts of the committee to clarify the applicability of new source review procedures. We are particularly concerned that the existing EPA WEPCo procedures not be applied to utilities using clean coal technologies to comply with Clean Air Act requirements. We support legislation, if necessary, to adequately resolve EPA's interpretation of its WEPCo policy.

We have these suggested additions to title V. The programs outlined form a blueprint for development and deployment of coal technology. Additional components would complement S. 341's goal, and these have been mentioned here a little earlier already. First, coal liquefaction, a longer-term program. Second, programs to encourage commercial use of clean coal technologies, and coal slurry pipelines would have an effect in the shorter term.

On coal liquefaction, the greatest unrealized potential for coal use is in the transportation section. We are seeking to develop a significant capability to provide alternatives to conventional motor fuels. You zeroed in on the concept of coal refineries. It has been around for decades. Coal gasoline is a predominant form of transportation fuel in South Africa. Many variations to the refinery concept from mild gasification to mild liquefaction all are capable of making a contribution towards reducing dependence on imported petroleum.

They have been pursued as a matter of national policy in a sporadic way. It is difficult if not impossible for private industry to pursue extended research and demonstration projects or make the investments necessary within the short periods of time. Section 5006 should include direction to develop a program to support commercial scale deployment of several coal-based alternative fuel plants using differing technologies. This could be accomplished by the end of this decade.

There are other opportunities which could provide a timely link between the need to develop coal-derived transportation fuels and other national policy objectives. The U.S. continues to expand and fill the strategic petroleum reserve. We support this and suggest that the committee consider directing the Secretary to develop a plan to require that some component of the petroleum reserve be coal-derived liquids.

Clean coal tech commercialization. We need a program that would have a near-term effect to deploy a program which would facilitate the commercial use of clean coal tech. A new generation of technologies is difficult. Incentives to encourage the investment of limited capital in the use of clean coal tech is projected to result in markedly reduced cost for emission reduction strategies. The benefits of cost merits and incorporation of incentive programs could be put into S. 341.

We were encouraged, Mr. Chairman, by the Assistant Secretary's statement today that the administration is interested in working with the committee to develop legislative incentives for commercial use of clean coal tech. We are also interested in working with the committee to develop clean coal tech deployment incentives for which legislation is necessary.

Separately, we encourage the committee to direct the Secretary to establish a coal technology commercialization task force to formulate policy recommendations for the incentives necessary to commercialize clean coal tech. The task force, building on the work of the innovative control technology advisory panel and the National Coal Council should be directed to identify barriers to commercialization and prepare an action plan to address these barriers.

The plan, which may not necessarily require legislative action, should include recommendations to be implemented through FERC rulemaking procedures and outreach programs to state public utility commissions. Recommendations by the task force should not be limited to regulatory incentives, but should also embrace modifications to the tax treatment of investments in clean coal tech.

Because of its prior work in this area and the diversity of its membership, we would recommend that the Secretary utilize the National Coal Council to establish the task force. The initiative would be consistent with them emphasis on expanded use of more advanced coal technologies in the administration's national energy strategy.

Coal slurry pipelines. S. 341 does not address coal slurry pipelines. For reasons already known to this committee, the coal industry has consistently supported coal slurry legislation and supports the administration's NES recommendation.

Mr. Chairman, we appreciate the opportunity to offer our views and suggestions on S. 341. I would be happy to answer any questions you might have either now or later, as the committee develops the provisions of this important legislation.

[The prepared statement of Mr. Katlic follows:]

SUBCOMMITTEE ON RESEARCH AND DEVELOPMENT
COMMITTEE ON ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE

HEARINGS ON
S. 341
THE NATIONAL ENERGY SECURITY ACT OF 1991

STATEMENT OF THE NATIONAL COAL ASSOCIATION
JACK E. KATLIC, CHAIRMAN

MARCH 19, 1991

Mr. Chairman, members of the Committee, I am Jack E. Katlic, Sr. Vice President of American Electric Power Service Corporation (AEP). AEP is one of the largest electric utility systems in the United States providing electrical service to seven million people in a seven state area stretching from Michigan to Tennessee. Ninety percent, or 21,000 MW, of our generating capacity is fueled by coal. In addition to being the largest coal user in the United States, AEP is a leader in the development and demonstration of clean coal technologies. I am here today however, in my role as Chairman of the Board of Directors of the National Coal Association (NCA). My statement is a direct reflection of the views of the NCA and the coal industry.

National Coal Association (NCA) is an organization which represents producers of coal from the smallest to the largest. NCA members, which comprise most coal production in the United States, operate in all producing regions of the country, mine all qualities of coal and supply both domestic and foreign markets.

Mr. Chairman, I would like to commend you for your long term and unwavering support for coal and your support for an increase in coal use to meet this nation's energy requirements. You, and all the members of this committee, clearly recognize that our nation must reduce our dependence on imported oil. We must make the hard decisions that are necessary to ensure a stable, secure energy supply for the Nation in the decades to come. You know that these decisions must be made now - not at some distant time in the future. And, these decisions must include those that encourage the greater use of our largest domestic resource, coal, both in the short term (over the next decade) and beyond - well into the next century.

Policies that effect energy, the economy and the environment are closely intertwined and must be carefully balanced to meet the requirements of all simultaneously. This is a primary reason that S. 341 was introduced; as stated in Title One:

> "Congress finds that: the achievement of energy security for the United States is essential to the health of the national economy and the maintenance of national security....which can be accomplished with no significant adverse effect on the environment..."

Never has achievement of energy security been more important to our nation. The events of the last several months in the Middle East have only served to emphasize the importance of a viable National Energy Strategy. This nation must act, and act now, to reduce dependence on imports of oil to below the current 50 percent figure.

We must increase the production and use of our all domestic energy resources: oil, natural gas, coal, uranium and renewables. Further we must find a way to conserve our resources and to use them more efficiently. We do not have to say no to economic growth and future prosperity. We can attain our goals with technology without adversely affecting either our economy or the environment.

Many of the proposals included in S. 341 will advance the nation along the path of energy security in a manner that is compatible with continued economic growth and protection of the environment. NCA is pleased to support the objectives of S. 341 and those aspects of this legislation as they relate to coal.

As requested, our statement will be limited to the provisions included in Title Five, "*Coal, Coal Technology and Electricity.*" Before commenting on Title Five, it is appropriate to review the outlook for energy demands both in the United States and abroad. We will then assess the role that coal, especially United States coal, should play in meeting those demands. Our statement will then address the specific provisions of Title Five and conclude with several suggestions on the ways that S. 341 might be extended to enhance coal's use.

I. THE IMPORTANCE OF COAL IN OUR ENERGY FUTURE.

As already stated, S. 341 recognizes that the economic future of the United States is dependent on an adequate, reasonably priced and secure energy supply. The energy/economy relationship is well established not only in the United States, but throughout the world,in both developed and developing nations. Adequate, secure and reasonably priced energy supplies are imperative to sustain economic growth, improve standards of living and support an expanding population.

The 1980's, which have generally been a period of economic growth, low inflation and general prosperity, offer an excellent example of this important relationship. Advances in conservation and in efficiency have allowed greater economic growth with less energy use. But it is no coincidence that this period has also seen an unprecedented increase in the use of our most plentiful fossil fuel resource - coal.

IN THE UNITED STATES: Since 1973 the GNP in the United States (measured in 1982 dollars) has increased by over 51 percent -- or by 2.5 percent annually on average. Energy use increased by only 10.8 percent over the same time (an annual 0.6 percent), and the energy intensity ratio -- the ratio of energy use per $ GNP -- declined by 27 percent. At the same time, the nation's use of coal increased by 62 percent and coal's contribution to total U.S. energy requirements increased from 17.5 percent to 23.5 percent.

IN THE REST OF THE OECD: The same general trends have been evident throughout the other countries of the OECD. Excluding the United States, growth of real GNP between 1973 and 1989 was a total of 56 percent, an average annual 2.8 percent. As in the United States the energy intensity ratio declined, by 23 percent. However, the United States made more progress in efficiency improvements than the rest of the OECD nations on average. Energy use in the OECD excluding the U.S. increased by 20 percent or by an average 1.1 percent annually (one have percent per year greater than our own experience). As in the United States, coal use increased, but by a far lesser amount, by 15 percent. (It should be noted that much of the increase in coal use was supported by the United States as one of the world's largest coal exporters.)

Economic growth with less energy in both the U.S. and the developed world, has been possible through conservation and by advances in the efficiency of both energy conversion and final energy use. These factors will be important in the future, as will commercialization of new technologies which will allow the economies throughout the world to continue to grow at a faster rate than the increase in energy use.

WHAT ARE FUTURE ENERGY REQUIREMENTS LIKELY TO BE? There are many forecasts on energy requirements that illustrate the sharply differing expectations of energy needs in the various economic regions of the world.

Energy requirements in the United States are forecast to increase by an average 1.3 percent per year through 2030. Today's energy consumption of 82 quadrillion Btu (quads) will be over 140 quads by 2030 according to the base case estimates included in the National Energy Strategy prepared by the U.S. Department of Energy.

A recently published forecast prepared by the Office of Technology Assessment, "Energy in Developing Countries," predicts that energy demand in all OECD countries will increase at the same annual rate - 1.3 percent - over the next 20 years.

The incremental energy demands of the developed world will be dwarfed however, in comparison to the new energy needs of the developing world, the USSR, China and Eastern Europe. In these countries energy use is expected to increase geometrically to support sharp growth in population while simultaneously trying to improve the economic status of each economy.

The OTA assessment, which is summarized in Table 1 attached, shows that the rate of increase in energy demand in developing countries through 2010 is expected to average 3.8 percent per annum, almost 3 times that of the OECD. The expected rate of growth in energy demand in the USSR and Eastern Europe also tops that of the OECD. It is expected to average an annual 2 percent over the next 20 years.

By 2010, total world energy requirements will be 71 percent greater than today. Almost 60 percent of the energy consumed in the world by then will be in the bloc now called "the developing nations" and in the USSR-Eastern Europe complex. Providing for this sharp increase in energy - which will be needed to support an equally sharp increase in population - at the same time that new domestic energy needs must be met, will present the United States and the rest of the developed world with a challenge that is without parallel.

As energy demands increase, economies will become more dependent on electricity to met end use energy requirements. In the United States, electricity met 29 percent of 1973 end use energy needs. In 1989 this figure was 36 percent. By 2000, DOE projections show that 41 percent of U.S. end use energy requirements will be met with electricity and by 2010, that dependence will be over 45 percent.

The increase in dependence on electricity is equally as notable in other OECD countries. As in the United States, use of electricity is expected to be even greater after the turn of the century. Efficient electricity will also increase in importance throughout the developing world.

We must realize that despite all efforts, demand for energy will not decline unless economic activity declines for fiscal, monetary or business cycle reasons or because energy is unavailable or because it is only available at prohibitive costs. Government and industry must work together to ensure that these future requirements are met.

WHY COAL??

In reality, the challenge is not if coal will be used. Rather the challenge is how to assure its most efficient utilization and how to employ technologies that assure coal's full use with minimal impact on the environment. The challenge extends beyond the United States borders to all countries throughout the world.

United States policies that encourage the greater use of coal, the one domestic energy resource that can be used in greater quantity without an appreciable increase in cost, can assure that new demands for energy at home can be met. At the same time, United States policies to foster the greater use of coal and more advanced coal conversion technologies in the developing world can help guarantee that these ever increasing energy requirements are met in the most cost effective and environmentally acceptable manner possible.

Renewable energy, greater efficiencies and conservation will play an important role in meeting these new energy demands. S. 341 includes many provisions which, if implemented, will hasten the time in which these energy sources will be available on a large commercial scale. However, these sources must still be considered in the time frames in which they can be commercially deployed. Under the most favorable circumstances, these options will not be available until well into the next century on a sufficient scale to meet even incremental demands for energy to say nothing of replacing current energy sources.

For a number of decades, fossil fuels will be the major source of energy in the United States and world wide. Even with the significant policy changes proposed by the

Administration's National Energy Strategy and by this legislation, nuclear power will not be viable source of new energy for some time to come. Because energy security is a prime goal, oil, particularly imported oil is not viable. Natural gas use will expand to meet a part of increased energy demands, but the reserve base, production capacity and transportation capability are not sufficient to satisfy all demands, even with significant price increases.

Competitively priced, available and secure coal will continue to be the dominant fossil fuel and the option of choice.

In the United States, coal accounts for 32 percent of domestically produced energy at the current time and fuels 57 percent of the electricity generated in the United States. Over one billion tons of coal are mined in the U.S. today. This coal is being mined and burned today while meeting all environmental standards, and with emissions that are lower than 10 years ago. And, with technologies that are available now or in the very near future, coal can be used more efficiently and in even greater quantities with even lower total emissions.

Coal reserves, which represent over 80 percent of the world's fossil energy base, are over 90 percent of the economically recoverable fossil fuel reserve base of the United States. This is a reserve that can support centuries, not decades, of use.

Coal will be used as a base load fuel to generate electricity. In the United States, coal consumption for electric generation is expected to increase from today's 770 million tons to 1.1 to 1.3 billion tons by 2030. Capacity to burn this coal will increase accordingly.

Projections in a recent report of the Electric Power Research Institute[1] show that coal capacity world wide will double over the next 30 years. Table 2 appended to this statement shows the distribution of that new capacity. Almost 60 percent of the 870 GW capacity expected to be built before 2020 will be in the areas of greatest energy demand growth - the developing countries, the USSR and in Eastern Europe.

There is yet another use for coal. With the development and deployment of new technologies, coal will be used in more unconventional ways: to replace petroleum in the transportation and industrial sectors; in applications that are essentially "non fuel"; and, gasification and liquifaction of coal could become commonplace.

Without the use of coal, a National Energy Strategy such as that proposed either by the Administration or in S. 341, could not hope to succeed. Without coal, oil imports (and our dependence on an expensive and unsecured energy supply) will increase. Without coal, energy - and electricity supplies - will be insufficient to maintain even the current level of economic activity.

With this background - and the knowledge that coal will be used in ever greater quantities in the future in the United States and throughout the world - we would like to discuss S. 341, Title 5 and the provisions included in this legislation that will provide the backdrop for actions to ensure that coal will continue to be used cost effectively and in an environmentally accepted manner.

II. "COAL, COAL TECHNOLOGY AND ELECTRICITY" Title V - S. 341.

Title V is intended to "enhance the role of coal and clean coal technology in meeting the nation's energy needs." The programs and reports that are required by

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[1] "The Role of Coal in Powering the Second Electrical Century", Kurt E. Yeager, EPRI, at the 1990 International Committee for Coal Research Meeting, October 9, 1990

S. 341 will assist in accomplishing this goal over the long term in two broad ways:

(1) through development of programs that include research and demonstration of more technologically advanced ways to use our resource for the traditional generation of electricity, and

(2) through study and recommendation of the best research areas or other actions that would be required to enhance coal use in new areas, as a fuel to replace petroleum directly, especially in the transportation sector, and for non-fuel requirements.

S. 341 goes beyond our nation's borders by recognizing the essential role of U.S. coal and U.S. coal technologies in meeting the growing energy needs of developing economies throughout the world.

Section 5001

Under this provision the Secretary of Energy is directed to establish a research, development and demonstration program for advanced coal based technologies. We would recommend that this program, which will result in a new generation of technologies, be patterned after the highly successful industry/government Clean Coal Technology (CCT) Program.

Projects that began in 1986 under the first round of the original CCT Program are just now at the point of becoming commercially viable. Completion of the original CCT program later in this decade will result in a suite of state of the art technologies that apply to the entire fuel conversion cycle, from pre combustion to combustion to post combustion clean up.

Coal can be burned with several of these technologies, including AFBC, PFBC, IGCC to name just three, while meeting the more stringent Clean Air Act (1990) standards for emissions of SO2 and NOx. In a greenfield installation CCT's can be used at projected lower costs than are possible using current technology.

Perhaps more significant is the increased efficiency of these more advance technologies. Current coal fired electric power generation units in the United States operate at an average 33 percent thermal efficiency. Advanced systems such as those developed under the CCT program can increase power generating efficiency to over 40 percent. This means that the same amount of electricity can be generated with approximately 25 percent less coal.

I might add Mr. Chairman, AEP is in the forefront of developing clean coal technology. Our Tidd Plant, a state of the art pressurized fluidized boiler, began operation earlier this year. This technology will be scaled up from a 70 MW size to 330 MW at our Sporn generating station by the end of this decade.

With a program that is targeted to deploy these new technologies in commercial scale applications, several technologies now being demonstrated under the CCT program will be available for commercial scale generation in the near future. This will assist the utilities, cogenerators and independent power producers as they meet new demands for electricity over the next two decades.

But, time cannot stand still and technology development cannot be allowed to stagnate. Development of the next generation of clean coal technologies must begin now if they are to be commercially available to meet increased electricity demands early in the next century. Sec. 5001 sets forth the essential framework for development of the next generation of technology to address increased demand for electricity.

We support the focus of Sec. 5001 for a program designed to develop advanced coal based technologies with even greater efficiencies and lower emission rates. The program should again follow the lead of the current CCT effort through support for a wide menu of technologies.

Some research and development work on advanced clean coal technologies has either been done or is now underway in both government and private industry efforts. The report required by Sec. 5001(b) will identify advancements already made, information already available and will help to target the areas where new initiatives are most promising. The Secretary should be specifically directed to use this report when designing the outlines of the research program required by Sec. 5001(a). The coal industry will be an active participant in this effort and in recommending research priorities.

We would be remiss if we did not mention our disappointment and concern with the Administration's proposal to redirect funds already appropriated for Round Five of the current Clean Coal Program. We urge the committee Mr. Chairman, to oppose any reprogramming request submitted to the Congress.

Section 5002

Sec. 5002 directs the Secretary to develop a plan for research, development and demonstration of technologies for non-fuel uses of coal. Approximately 50 - 60 million tons of coal are now used now in a variety of ways that are not direct combustion for the production of steam and electricity. Use by the steel industry for the production of coke is the most familiar "non fuel" use of coal, but coal is also used to make cement, as a feedstock for a number of chemicals and is used in other manufacturing processes. Additionally, by-products of coal combustion - ash, sulfur, carbon dioxide - are being used for a variety of purposes. These uses can be extended. Coal can take the place of petroleum for some industrial purposes. The plan the Secretary is required to develop under this section should serve as a blueprint to identify those opportunities and to establish priorities for research that will result in commercialization of technology for non-fuel uses of coal.

We would make two suggestions regarding the preparation of the research program to be conducted under this section:

(1) that the Secretary be instructed to establish an advisory committee comprised of representatives of manufacturing or other industries that are current or potential "non-fuel" users of coal, representatives of the coal industry and representatives of other relevant government agencies such as the EPA and Department of Commerce to assist DOE in developing its information and in prioritization of its research suggestions, and
(2) that the plan include a survey of the technology and research programs for non-fuel uses of coal as they exist in other developed countries.

Section 5003 and 5004

These provisions address the potential to increase the role that U.S. coal and U.S. coal technologies can play in the foreign market. As discussed earlier in this statement, coal will be used in ever increasing amounts throughout the world. The rate of growth in energy use will be far greater in the developing world than in the U.S. or in other OECD countries for two reasons: the need to provide energy for a growing population and the need to move beyond bare subsistence levels. Coal will be used either because it is an indigenous resource or because it is the least costly and most readily available fuel.

The United States has the coal resource, the export infrastructure and the technology base to support this increase in coal use. The United States now exports approximately 10 percent of our production, or 100 million tons, annually. U.S. coal exporters ship both metallurgical and steam coal to countries around the globe. Within the OECD, countries of the European Community, Canada and Japan are major markets. Within the community of developing nations, Brazil, Argentina, Taiwan and Korea are major customers for U.S. coal. The production capacity, inland transportation and ocean port infrastructure is in place to export at least twice current annual volumes.

Sec. 5003 requires the Secretary to prepare a report identifying potential foreign markets for U.S. coal (including the potential for blending with indigenous resources) and barriers that the U.S. exporter might encounter in these markets. The Secretary is further directed to evaluate the U.S. exporting infrastructure and to recommend action plans for addressing impediments identified. Sec. 5004 establishes a "Clean Coal Technology Export Advisory Council to do much the same thing with respect to export of U.S. CCT's.

The future market for U.S. coal is inexorably entwined with the deployment of clean coal technologies worldwide. Therefore we would suggest that these two sections be combined and that the reports required in each cover both coal and coal technologies. The Advisory Council can direct this integrated effort.

Much of the information required by Sec. 5003 (especially as relates to coal markets in the OECD countries) has either been done or efforts to complete the work is already underway by the Department of Energy, the Department of Commerce, by other U.S. government agencies and by the IEA. We would urge the Secretary to take full advantage of this background material, not to repeat what has already been done but rather to identify the information gaps and expeditiously address them.

This effort would focus, in part, on two specific but diverse areas. First, what are the reasons that coal is not penetrating markets in OECD countries at a faster pace. What are the concerns, local attitudes or laws, that inhibit the use of coal and what actions can the U.S. government take to address these restrictions.

Second, the Department should make a specific effort to identify the energy needs of the developing countries, with the input of each respective government. The DOE should then work with these governments to develop a plan to integrate coal technology, and, if appropriate, U.S. coal in meeting these requirements in ways that are most advantageous to each individual country. The final step is to inform and work with U.S.

industry to take advantage of the opportunities which are identified through this effort. Both coal companies and builders of clean coal technologies would benefit.

Market barriers to the import of coal do exist. The DOE has identified many of them through their work with the IEA and internally. For example, as the Department of Energy pointed out in an EIA report two years ago, government subsidies to domestic coal industries in Germany, the United Kingdom and Japan curtail market opportunities for all coal exporters. We urge the Department to continue to work with the US Trade Representative and other agencies as appropriate in the ongoing GATT negotiations and through other existing international fora, to encourage elimination of these practices or others that may inhibit the use of imported coal.

We are very encouraged to note that S. 341 specifically directs the Export Advisory Council to address the financial barriers that prevent U.S. manufacturers and exporters from expanded participation in overseas markets - especially in the developing world. Too often a U.S. company, having spent time and money to develop new business opportunities, is then forced to compete with "concessionary financing" from overseas competitors. There is a clear role for the United States government in meeting these forms of competition. NCA fully supports the establishment of programs to facilitate access to capital and credit for financing clean coal technology projects and coal in foreign markets.

More specifically, loan programs should require that a certain percentage of the coal burned in the financed facility be from the United States. Such "tied aid" is prevalent throughout the world with the exception of the United States and should now be seriously considered by the Administration and the Congress. It would seem to be counterproductive for the U.S. government to finance a U.S. clean coal technology project abroad so that the project can burn coal imported from another country.

Section 5005

Coal generally cannot directly replace petroleum. However, advances in coal/water and coal/oil mixtures could change this and make direct substitution possible with only minor equipment modifications. Sec. 5005 requires a report that assesses the status of development and economic feasibility of these technologies. The Department of Energy is now conducting a project to test the feasibility of using coal/water mixtures in a boiler designed for oil with ENEL, the state owned electric utility in Italy. The results of this project should give the Department the basis for much of the information required for a thorough analysis of the potential for coal/water. These technologies offer a near term opportunity for coal to replace imported oil in utility and industrial applications.

Section 5006

An additional area where coal can reduce our dependence on imported oil is in the transportation sector. Transportation in the U.S. economy is a means to move energy resources to end-use markets and is also a major consumer of energy in its own right. According to the Interagency Commission on Alternative Motor Fuels, "Reliance on conventional fuels has left the U.S. transportation system 98 percent dependent on petroleum.... Transportation accounts for more than two-thirds of the nation's petroleum use and more than 80 percent of the high-value light products."

Sec. 5006 addresses one aspect of transportation fuel use. Commercial demonstration of coal-fired diesel engines capable of competing on a cost-effective basis with conventional diesel powered locomotives could significantly reduce dependence on petroleum imports.

Section 5008

This section establishes a data base on coal transportation rates and directs the Secretary to study the rates and distribution patterns of domestic coal to determine the impact of Federal policies on both. The coal industry supports this effort. This information will be helpful in evaluating the individual components of compliance costs associated with implementation of the Clean Air Act.

We would like to propose that the data base and study not be limited to rates for moving coal to domestic destinations only. As mentioned earlier, 10 percent of our production is exported in a highly competitive world market. Extension of the rate data base to include export rates, and evaluation of the impact of Federal policies on export rates and their effect on U.S. coal competitiveness would be equally useful as U.S. coal expands its role throughout the world.

Section 5101

Finally, NCA strongly supports the efforts of this committee to clarify the applicability of new source review procedures to existing electric utility steam generating units. This will be especially important if the Administration does not administratively address the "WEPCO" problem expeditiously. NCA is particularly concerned that the existing EPA "WEPCO" procedures not be applied to utilities utilizing Clean Coal Technologies to comply with Clean Air Act requirements. NCA specifically endorses the statement given on Monday, March 18, 1991, by Anthony J. Ahern of AEP (on behalf of American Public Power Association, Edison Electric Institute, NCA, and National Rural Electric cooperative Association), stating that legislation may be necessary to adequately resolve EPA's interpretation of its WEPCO policy.

III. SUGGESTED ADDITIONS TO TITLE FIVE

The programs outlined in Title Five, will form the basis for the development of technologies that will allow greater use of coal well into the future. The reports required will give both government and industry a "blueprint" for planning for and prioritizing development and deployment of technologies. There are however, several additional programs that should be included in S. 341. The first, coal liquifaction, is a longer term program. Second, programs to encourage commercialization of clean coal technologies and to expand our nations coal transportation system with the addition of coal slurry pipelines would have an effect in the shorter term.

Coal Liquifaction

As pointed out the greatest unrealized potential for coal use is in the transportation sector. Sec. 5006 addresses only part of the transportation question - rail transportation requirements. The U.S. is seeking to develop a significant capability to provide alternatives to conventional motor fuels beyond the rail transportation sector. Coal derived fuels can, and should, play a major role in this emerging industry. The research program required under Sec. 5006 could be incorporated into a larger research and development program to produce both gaseous and liquid transportation fuels from coal.

The concept of "coal refineries" has been around for decades, and in fact, coal gasoline is the predominant form of transportation fuel in South Africa. There are many variations to the coal refinery concept, ranging from mild gasification to direct liquefaction. Some produce feedstocks, some produce solid fuels. All are capable of making a contribution toward reducing dependence on imported petroleum whether in the transportation or in other sectors.

Coal gasification and liquefaction have been pursued as a matter of national policy in a very sporadic way. It is difficult, if not impossible, for private industry to pursue extended research and demonstration projects or make the investments necessary to develop the technologies required for a viable alternative fuels industry when fuel prices are not stable, but rather can change by wide margins (up and down) within a short period of time. Sec. 5006 should include direction to the Secretary to develop a program to support commercial scale deployment of several coal based alternative fuel plants using different technologies. This could be accomplished by the end of this decade.

There are a number of opportunities which could provide a timely linkage between the need to develop coal-derived transportation fuels and other national policy objectives. Beyond the aforementioned alternative fuel policies, the U.S. continues to expand and fill the Strategic Petroleum Reserve. We support this and would suggest that it might be appropriate to consider directing the Secretary to develop a plan to require that some component of the SPR be coal derived liquids.

The coal industry stands ready to work with this committee and the Administration to develop these and other approaches to a U.S. coal based alternative fuels industry.

Clean Coal Technology Commercialization

With the exception of the programs required to enhance exports of coal and of clean coal technologies, the positive impacts of the coal related programs included in S. 341 will not be experienced for several years.

A program not included in Title Five that would have a more immediate effect is a deployment program to facilitate commercial use of the Clean Coal Technologies currently being demonstrated.

Commercialization of a new generation of technologies, particularly those with high capital costs, is difficult. The utilities that are the likely candidates for the "first use" of these new technologies are not encouraged to take the risks of utilizing new and possibly unproven technology. Positive incentives are appropriate to encourage both utilities and independent power producers to utilize these new, more efficient and environmentally sound, technologies.

This is especially important as utilities are faced with very short time deadlines to meet the provisions of the Clean Air Act Amendments of 1990. There is a limited pool of capital available to meet these new requirements while at the same time providing for new electricity demands. If a risk adverse utility opts for existing compliance options, the capital allocated for that purpose will delay the use of newer more efficient technologies until well into the future.

Incentives to encourage the investment of limited capital in the use of clean coal technologies is projected to result in markedly reduced costs for emissions reduction strategies. The benefits of reduced power generation costs merit incorporation of an incentive program to encourage CCT use in S. 341.

Rate incentives, accelerated depreciation of capital costs, prudency provisions and other incentives, were extensively evaluated by the Innovative Control Technology Advisory Panel (ICTAP), established by the Department of Energy, and by the National Coal Council (NCC). Both groups issued separate reports on deployment of Clean Coal Technologies with detailed recommendations to the Secretary of Energy in 1988 (ICTAP) and 1989 (NCC).

We are interested in working with the Committee to develop clean coal technology deployment incentives for which legislation is necessary. Separately, we encourage the Committee to direct the Secretary to establish a Coal Technology Commercialization Task Force to formulate policy recommendations for the incentives necessary to commercialize CCTs.

The Task Force, building on the work of ICTAP and the National Coal Council, should be directed to identify barriers to commercialization and prepare an action plan to address these barriers. The plan, which may not necessarily require legislative action, should include non-legislative recommendations to be implemented through FERC rulemaking procedures and outreach programs to state public utility commissions.

Recommendations addressed by the Task Force should not be limited to regulatory incentives but should also embrace modifications to the tax treatment of investments in qualified clean coal technologies.

Because of its prior work in this area, and the diversity of its membership, we would recommend that the Secretary utilize the National Coal Council to establish the Task Force. This initiative would be consistent with the emphasis on expanded use of more advanced coal technologies in the Administration's National Energy Strategy.

Siting and permits

The problems of siting, permitting, construction and operating new energy facilities are well known. Utilities cannot build needed generating facilities. Independents are experiencing an equally difficult task as they seek to enter the business of generating electricity. Transmission lines are difficult to build as are natural gas pipelines, refinery capacity, and the list could go on. A great deal could be accomplished for all domestic energy facilities by seeking constructive solutions to the "not in my backyard" syndrome and to the overly burdensome regulatory process that is now the prerequisite to any attempt to site and construct new energy facilities. S. 341 proposes to partially address this issue in Title VIII, Sec. 8001; Title X, Sec. 10001 and 10002 and in Title XIII. We would encourage the committee to explore broader solutions.

Coal Slurry Pipelines

S. 341 does not address coal slurry pipelines. Pipelines can offer an efficient and competitive means of transporting coal to certain end use markets. The National Energy Strategy recommends support for legislation to grant a federal power of eminent domain to qualified coal slurry pipelines, provided that they are able to satisfy regional and state concerns about water rights. For reasons already known to this committee, the coal industry has consistently supported coal slurry legislation and supports the Administration's recommendation.

Mr. Chairman, we appreciate the opportunity to offer our views and suggestions on S. 341. I would be happy to answer any questions that you might have either now or later as the Committee develops the provisions of this important legislation.

Table 1

COMMERCIAL ENERGY CONSUMPTION, 1985 AND PROJECTIONS FOR 2010 (EJ=Exajoules)

	1985 (EJ)	Share of total percent	2010 (EJ)	Share of total percent	AARG,[a] 1985-2010 percent	Increase in consumption, 1985-2010 (EJ)	Share of increase percent
Developing countries	69.26	23.3	175.56	34.5	3.8	106.30	50.2
China	21.91	7.4	59.54	11.7	4.1	37.63	17.8
OPEC	11.65	3.9	28.91	5.7	2.5	17.26	8.1
Non-OPEC developing countries	35.70	12.0	87.11	17.1	3.6	51.41	24.3
TOTAL OECD	155.83	52.4	215.03	42.2	1.3	59.20	27.9
United States	73.87	24.8	98.47	19.3	1.2	24.60	11.6
OECD except United States	81.96	27.6	116.56	22.9	1.4	34.6	16.3
U.S.S.R. and Eastern Europe	72.32	24.3	118.66	23.3	2.0	46.34	21.9
Total	297.41	100.0	509.25	100.0	2.3	211.85	100.0

[a] AARG - annual average annual rate of growth.

SOURCE: Alan S. Manne and Leo Schrattenholzer, *International Energy Workshop: Overview of Poll Responses (Palo Alto, CA: Stanford University International Energy Project, July 1989).*

Table 2
Coal-Fired Generating Capacity Growth

	1990 Installed Coal Capacity (GW)	Expected Coal Growth 1990-2000		Expected Coal Growth 2000-2020	
		%/Yr	New GW	%/Yr	New GW
N. America	340	1.0	30	2.0	180
W. Europe, Japan, Australia	220	2.0	40	1.5	100
E. Europe, USSR	250	1.1	30	1.5	100
China, India, Africa	200	1.3	30	2.0	110
Pacific Rim, S. America	60	7.5	60	4.7	190
TOTAL	1040		190		680

SOURCE: Electric Power Research Institute, "The Role of Coal in Powering the Second Electrical Century, October 1990

Senator FORD. Thank you very much.

Mr. Yamagata.

STATEMENT OF BEN YAMAGATA, EXECUTIVE DIRECTOR, CLEAN COAL TECHNOLOGY COALITION

Mr. YAMAGATA. It is good to be here, Mr. Chairman.

My name is Ben Yamagata. I am testifying today in my capacity as executive director of the Clean Coal Technology Coalition. I am going to limit my comments to three areas.

First, the administration's budget request to terminate round five of the ongoing clean coal program; second, EPA's implementation of the clean coal provisions contained in the Clean Air Act amendments of last year; and finally, our recommendations regarding those provisions contained in S. 341 that address the development and use of clean coal technologies.

First, Mr. Chairman, the Coalition strongly opposes the administration's budget recommendation to cancel round five. Since submission of this year's budget, and as you heard today, that clean coal program may not be terminated after all, notwithstanding what the budget appendices said. Rather, round 5 will merely be suspended so that promising technologies now on the drawing board or in the laboratory have enough time to mature sufficiently for possible demonstration under a delayed round 5.

While we support the eventual demonstration of promising new clean coal technologies currently in the development pipeline, we do not support a 1- or 2-year delay. If industry is willing to come forward with dollars and good project proposals, then the government, as promised, should move forward rapidly to ensure that round 5 is undertaken with the funds already appropriated and on the schedule already directed by public law.

Second, Mr. Chairman, I want to note our growing concern over EPA's implementation of provisions in the Clean Air Act amendments that directly address clean coal technology. In last year's clean air legislation DOE clean coal project demonstrations are to be exempted from certain provisions of the Clean Air Act. These exemptions were intended to address the so-called WEPCo problem which has been the subject of a hearing before this committee yesterday.

The exemption language adopted in the Clean Air Act amendments is unambiguous, and those exemptions should be declared self-executing with respect to DOE clean coal demonstration projects. We are concerned, however, that EPA is about to prescribe that a clean coal project must apply for an exemption and undergo EPA scrutiny in order to obtain the statutory exemptions.

In fact, yesterday Dr. Schmalensee testified that EPA may issue an interpretive ruling to address WEPCo. If that ruling mirrors last year's proposed interpretive ruling, we believe it will be very unfortunate indeed. DOE-supported clean coal projects must proceed under already agreed upon time schedules. An unnecessary application process and perhaps lengthy EPA review of such applications may render the statutory exemptions for clean coal valueless.

Finally, I would like to comment upon those sections of S. 341 that address clean coal technologies. Section 5001 of the bill requires the Secretary of Energy to establish a research and development and demonstration program for advance clean coal technologies. The Secretary is also required to provide to the Congress a report with recommendations regarding the need for a cost share program similar to the current clean coal demonstration program.

In light of the success achieved through the current clean coal program as ably described by Secretary Gentile, the committee may wish to consider amending section 5001 so that the Secretary is directed to report upon why the ongoing cost share demonstration program should not be continued to ensure the demonstration of advanced technologies rather than, as now drafted in the bill, a requirement that the Secretary simply report upon the advisability of continuing the clean coal program for advance technologies.

Section 5004 of the bill establishes a clean coal technology export coordinating council. The coalition supports the establishment of this council and we specifically support the requirement of subsection F, which directs the Secretary to make recommendations on actions that can be taken to improve clean coal technology exports. The National Coal Council, as estimated, that by the year 2000 there may be a potential to export as much as $50 billion per year in clean coal technologies.

We address that potential of worldwide market in our written testimony. Mr. Katlic addressed it better. That market is absolutely enormous. Given the leadership in technology development which this country currently enjoys, every reasonable effort should be made to ensure that the United States maintains its current technological advantage and is the principal supplier to the world of clean coal equipment.

Also, by encouraging the use of clean coal technologies in those regions of the globe that are looking toward energy from coal as a way to assist in economic development, we might best ensure that emissions will be effectively controlled. And because of their greater efficiencies, these technologies could also help to minimize releases of carbon dioxide.

In our written testimony we have suggested several amendments to the authorities of the Council. The duties and authorities of this Council must be sharpened and made specific in S. 341 if the council is to work. Otherwise, the Council will be what the name suggests, a council that may counsel.

Mr. Chairman, we have also included in our written testimony two additional amendments. The first amendment would modify the Public Utility Regulatory Policies Act, PURPA, to ensure that the rates provided a DOE clean coal demonstration project would not be included in the calculation of avoiding costs. And a second amendment would require the Secretary of Energy to report to the Congress upon the progress of Federal efforts undertaken as a part of the national energy strategy to encourage regulatory authorities to provide incentive for utilities to invest in innovative clean coal technologies.

That concludes my statement.

[The prepared statement of Mr. Yamagata follows:]

WRITTEN STATEMENT OF
BEN YAMAGATA, EXECUTIVE DIRECTOR
CLEAN COAL TECHNOLOGY COALITION

SUBMITTED TO THE
SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT
COMMITTEE ON ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE

MARCH 19, 1991

HEARING ON TITLE V OF S. 341
THE NATIONAL ENERGY SECURITY ACT OF 1991

This written statement is submitted by the Clean Coal Technology Coalition ("Coalition"), an ad hoc group of more than 80 entities including electric utilities, equipment suppliers, coal companies, architect-engineering and construction firms, state governments, universities, the National Coal Association, the Edison Electric Institute and the American Mining Congress. A complete listing of the membership is included as "Attachment 1" of this statement.

The Coalition was organized in early 1985 for the specific purpose of encouraging the demonstration, deployment and widespread commercialization of promising, new clean coal technologies. This statement addresses the following issues:

1. The goals and purposes of the current, on-going federal government and private sector initiative to encourage the commercialization of clean coal technologies under the Department of Energy's clean coal program;

2. The projected domestic and foreign markets for clean coal technologies and the projected impact of clean coal technologies on domestic and foreign coal markets;

3. The current status of the DOE clean coal program and the technologies under demonstration through that program;

4. The importance of -- and national benefits from -- continuing the DOE clean coal program through all five of the scheduled and funded rounds of demonstration project solicitations; and,

5. The recommendations of the Coalition to amend the National Energy Security Act (S. 341), in order to best encourage the development of the next generation of clean coal technologies and the export of technologies under development.

1. Goals and Purposes of the Federal Clean Coal Program

The federal clean coal program, first funded by the Congress in late 1985, was established to assist industry in furnishing the U.S. energy marketplace with a number of advanced, more efficient, more cost-effective and more environmentally responsive technologies designed to use coal or to control emissions from coal use.

The clean coal program recognizes that the risk-taking associated with investment in clean coal technologies is particularly acute in the electric utility sector which requires a high level of plant reliability and which depends upon regulatory approval to recover the cost of utility investments.

Typically, utility managers must satisfactorily answer the following questions before investing in a clean coal technology:

Will the technology work in commercial scale applications?

Will the technology be sufficiently reliable that management may count on the plant being available to meet service obligations to customers?

Will the investment be recoverable?

Are there affirmative reasons (e.g., greater efficiency,reliability, environmental performance) to justify the time and money required for project development?

Will changes in environmental regulation render the investment wasted and further jeopardize its recovery?

The proponents of the federal clean coal program recognized the need to undertake technology demonstrations to confidently address these types of questions. And, the creators of the clean coal program clearly recognized the national importance of enabling the electric utility industry to provide **environmentally acceptable**, cost-effective electric power generated from our vast domestic coal resources. The benefits of development and commercial deployment of clean coal technologies were deemed compelling enough for the federal government to take a leadership role by **sharing in the financial risks** attendant to the demonstration of these new technologies.

The clean coal program has fostered, and -- if the program continues as currently planned -- will continue to foster investments by the private sector in these environmentally and economically important technologies that help to assure our national energy security.

2. Domestic and Foreign Markets for Emerging Clean Coal Technologies and U.S.-mined Coal

Coal currently supplies the fuel for more than one-half of the electricity generated in this country. In fact, electric utilities consume almost 80 percent of the coal mined in the U.S. And, according to the Department of Energy, coal is projected to constitute over **60 percent** of all of the energy consumed by electric utilities by the year 2010.

America's recoverable coal reserves, which the Department of Energy places at 268 billion tons, are sufficient -- at even double today's rates of production -- to last this century, the next century and a significant portion of the century to follow. Without dispute, the U.S. has very significant supplies of coal to meet almost any level of increased demand.

Estimates vary as to the amount of new and replacement capacity that will be needed in the 1990's and beyond to power a growing economy. Electricity growth predicted by the Electric Power Research Institute (EPRI) and depicted in attachment 2, indicate a need for as much as 140,000 megawatts of new capacity.

Furthermore, the Department of Energy reports that by the year 2000, 44% of the nation's coal-fired capacity will be at least 30 years old. The aging U.S. boiler population and the need for new capacity could create a large domestic market for clean coal technologies since these technologies -- particularly the repowering technologies -- offer significant benefits over conventional technologies. (See attachment 3 which compares conventional technology with several new clean coal technologies.)

In addition to the significant domestic market for U.S. mined coal and clean coal technologies, there are very significant and potentially lucrative foreign markets for U.S.-mined coal and U.S.-developed clean coal technologies and technological know-how.

The Department of Energy estimates that through the year 2000, energy consumption in the European countries (OECD), Japan and developing countries will outpace the energy consumption growth projected for the U.S. In addition, the International Energy Agency (IEA) has projected that developing countries will consume more energy as a group than will Western Europe by the year 2000. Coal is expected to provide one-half to two-thirds of the additional energy needed by the world in the next 20 to 30 years. As an example of the magnitude of the potential markets, Asia and the Pacific Basin alone are expected to add 110,000 megawatts of new, coal-fired capacity by the end of this decade.

The expected growth in electric energy demand, coupled with the global trend toward more stringent environmental regulations, could present significant market opportunities for clean coal technologies.

The National Coal Council, an advisory arm to the Secretary of Energy, has projected that the world-wide market for clean coal technologies will be valued at $50 billion per year by the year 2000, and $70 billion per year by the year 2010. To capture a share of this valuable market, the U.S. must maintain its leadership in the demonstration and commercial use of clean coal technologies. The clean coal program, by developing environmentally and economically attractive coal-based technologies, can make the U.S. coal export package (e.g. coal, coal derivative fuels, coal-based technologies and technological know-how) a highly desirable commodity.

3. Status of the Federal Clean Coal Program

The on-going federal clean coal program, administered by the Department of Energy, has established a remarkably successful partnership between government and industry. From the government's perspective, taxpayer dollars have been highly leveraged to encourage industry leadership in the development and demonstration of new clean coal technologies.

Under the first three rounds of projects that have been selected for federal cost-sharing through the clean coal program, the Department of Energy has contributed approximately $1.3 billion -- or 38% of the funds necessary to undertake the projects. Industrial participants are providing approximately $2.1 billion -- or 62% of the total estimated costs of these projects. This private sector commitment is well in excess of the 50-50 cost-sharing required under the clean coal program. In addition, it is expected that many of the non-federal participants in these projects will **re-pay** some or all of the federal contribution to particular projects.

After three solicitations, the clean coal program has 35 projects underway or planned in fifteen states spanning the entire U.S. Of the 35 projects selected, 33 have been negotiated and are underway. The Department of Energy and industrial participants are still negotiating cooperative agreements for the other two projects.

Twenty of the projects selected thus far are retrofit technologies, seven are repowering technologies, five are new fuel forms, and three are industrial technologies.

The Coalition is currently undertaking an in-depth analysis of the types of clean coal projects selected by the Department of Energy. Our preliminary information indicates that the majority of retrofit technologies chosen for SO2 or NOx control are capable of only a low (less than 90%) reduction of emissions. There is little potential for use of those technologies in new facilities unless they are supplemented with other means of control. However, it might be expected that many of these technologies could be relied upon to bring existing powerplant units into compliance in time to meet the Phase II acid rain control requirements mandated by the Clean Air Act Amendments of 1990.

Repowering technologies, or other high efficiency/high emission control-capable technologies, have a smaller representation in the projects selected to date. These technologies, in addition to applications at existing facilities, represent the next generation of technologies that will be utilized at new powerplants and for new industrial energy requirements.

The solicitation for a fourth round of cost-shared projects under the clean coal program is expected to emphasize repowering technologies. The Program Opportunity Notice (PON) for Round IV of the clean coal program was issued in January, 1991. The Department of Energy (DOE) will provide nearly $600 million in federal funding under this round. DOE is required to select Round IV projects by the middle of September, 1991.

In sum, the federal taxpayer, through the DOE program, is making a wise investment in America's energy future: industry is leading the development program by assuming the larger portion of the dollar risk; important new technologies are being demonstrated and commercialized; the taxpayer will be repaid the dollars invested where appropriate; and, as importantly, we will continue utilization of our Nation's most abundant fossil fuel resource in a cost-effective and environmentally acceptable manner.

4. Need to Continue the DOE Program Through All Five of the Scheduled and Funded Rounds of Demonstration Projects

The Administration's budget request for fiscal year 1992 recommends **canceling** the fifth and final round of federal and private sector cost-shared demonstrations under the clean coal program. Public Law 101-121 provided $600 million in advance appropriations -- $150 million of which is currently scheduled to be made available in FY 1992 -- for a fifth and final round of projects. The fifth clean coal "Program Opportunity Notice" (PON) is required **by law** to be issued no later than March 1, 1992.

Funding for Round V of the clean coal program was appropriated **in advance**, in October of 1989, to assure industry that the government would cost-share in clean coal projects if industry were willing to commit itself to the development of these important technologies.

Presumably, this commitment was made at an early date to provide industry with sufficient time to plan ahead; to accelerate research and development efforts, if necessary; and to schedule technology development programs so as to most effectively take advantage of this opportunity for government assistance. We believe that industry has relied upon the conduct of a Round V in planning technology and clean coal project development schedules. Having relied upon the government's commitment to action, industry is now faced with the federal government advocating a change of course in mid-stream.

The Administration's fiscal year 1992 budget request defends the recommendation to cancel Round V by stating that the "Clean Coal Technology program's goal of obtaining $5,000,000,000 in combined industry/government funding will be met ahead of schedule and at the end of round four."

It is true that, because of industry's willingness to contribute funds well in excess of the 50% requirement of the program, $5 billion will likely be invested in the program by the end of round four. However, it is inappropriate to predicate cancellation of the program upon industry's willingness to shoulder more than its required share of the financial risk.

President Bush stated in his 1989 State of the Union address that his Administration would honor the commitment made to Canada to adopt the recommendations of the Special Envoys on Acid Rain, Drew Lewis and William Davis. The recommendation of the Special Envoys was not merely a $5 billion industry/government clean coal program. The recommendation specified that "The federal government should provide half the funding -- **2.5 billion dollars** -- for projects which industry recommends, and for which industry is prepared to contribute the other half of the funding." (Emphasis added.) Again, industry's willingness to provide more than its requisite share of funding should not thereby reduce the federal government's shared commitment to at least $2.5 billion of federal funds to the clean coal program.

Round IV of the clean coal program, as previously stated, will likely emphasize repowering technologies, or other high efficiency/high emission control-capable technologies. It is expected that Round V, as well, will place emphasis on these technologies which can benefit existing facilities as well as provide for the next generation of technology for use at new powerplants and for new industrial energy requirements.

The importance of continuing the clean coal program could never be more evident than today. Technologies capable of achieving greater emissions control at higher conversion efficiencies than currently possible will be an important means by which we might address concerns about oil imports, climate change and acid rain precursor control.

Second, continued and expanded work with new fuels derived from coal is very important to our efforts to supplement boiler and transportation fuels. We believe that other technologies, or different applications of existing technologies, have yet to be demonstrated; Round V could be very important in this regard as well.

Third, in order for industry to become confident in a new technology, the technology must first be successfully demonstrated in a variety of commercial-scale applications. Canceling Round V may prevent industry from proceeding with a sufficient number of demonstrations necessary to gain "user confidence." Without a high degree of confidence in the reliability and cost-effectiveness of a technology, utilities and industry will tend to use available, and proven, technologies.

Finally, by canceling Round V of the clean coal program, the United States could jeopardize its potential world-wide competitive advantage in development and commercialization of these important technologies. If the United States intends to remain a leader in the international market for clean coal technologies, it should not abandon the clean coal program just at that time when many of these technologies need to be further demonstrated and deployed to ensure a high degree of user confidence.

5. Recommendation of the Clean Coal Technology Coalition for Amendments to Title V

Senate bill 341 includes several sections in Title V of the bill that could directly enhance the use and development of clean coal technologies.

A. Recommended Changes to Section 5001:

Section 5001 of the bill requires the Secretary of Energy to establish a research, development and demonstration program within the DOE for advanced coal-based technologies. This program would be designed and administered to focus specifically upon those technologies that achieve high sulfur dioxide or nitrogen oxide control and those that achieve high thermal conversion efficiency.

The Clean Coal Technology Coalition supports the requirements placed upon the Secretary to undertake this research and development (R&D) program. We also support the reporting requirements imposed upon the Secretary. The Congress should be kept apprised of the framework within which this program would be established and the Secretary should be required to annually report upon the progress being made toward accomplishing the goals and objectives initially set forth in the Secretary's program. We would also urge this Committee to actively conduct oversight of this program as it is being developed and to seek industry input regarding the program's goals and objectives.

Subsection (b)(3) requires the Secretary to consider recommending whether or not to continue the clean coal technology demonstration program now underway in order to achieve the objective of commercializing advanced clean coal technologies by the year 2010. In light of the success achieved already through the current clean coal program, it is suggested that the Committee amend section 5001 (b)(3) so that the Secretary is directed to report upon why the on-going cost-share demonstration program should not be continued in order to best ensure that advanced clean coal technologies will be demonstrated and then commercialized in a timely manner.

The current clean coal demonstration program is proving to be instrumental in assuring that a vital link to commercialization, that is the demonstration phase, can be successfully accomplished through a government and industry partnership.

If this nation is committed to the use of its coal resources and the need to use these resources in the most environmentally acceptable manner possible, then continuing the support of advanced clean coal technologies, through a cost-sharing demonstration program, is advisable.

Section 5001 also lists several advanced clean coal technologies that would be included in the R&D program.

It is important to note that coal is utilized not only to generate electricity but also to produce power for industrial needs, including the energy needs of the steel industry. Any DOE program intended to develop and demonstrate new coal-using technologies should also emphasize industrial uses of coal. In this regard, the efficient and cost-effective control of toxic emissions that are designated under the Clean Air Act Amendments of 1990 should be a focal point for the proposed DOE advanced clean coal R&D technology program.

With respect to coal refining processes, referenced in section 5001 (d)(4), the Coalition supports clarification of the language in the bill to ensure that all processes, including those which utilize hydrocracking techniques, are included in the R&D program. Coal refining processes have the potential for removing sulfur and nitrogen from coal-derived fuels prior to combustion, thereby greatly reducing, and perhaps eliminating, the need for combustion or post-combustion emission control. Also, coal refining promises to produce coal-derived products not only to generate electricity but also to produce transportation fuels and chemical feedstocks. It is this ability to produce multiple products from coal -- and from all types and ranks of coal -- that make coal refining processes particularly attractive and worthy of government/industry joint development efforts.

B. Recommended Changes to Section 5004:

Section 5004 of the bill establishes a Clean Coal Technology Export Coordinating Council. The Coalition supports the establishment of this Council.

The Secretary of Energy is now conducting a study to examine various U.S. programs designed to encourage the export of clean coal technologies. This on-going study by the Secretary, mandated by section 409 of the recently-enacted Clean Air Act Amendments of 1990, is intended to do no more than to provide a report; it is not intended to provide recommendations for remedial actions. Subsection (f) of section 5004 would direct the Secretary to report to the Congress upon those actions necessary to effectuate the recommendations and findings of the on-going study. We support this provisions.

As noted previously in this statement, the National Coal Council has estimated that by the year 2000 there may be a potential to export as much as $50 billion per year in clean coal technologies and know-how. This potential market, according to the Coal Council's estimate, increases to $70 billion by the year 2010. Given the leadership in technology development which this country currently enjoys every reasonable effort should be made to ensure that the U.S. becomes the principal supplier to the world of clean coal equipment.

By encouraging the use of clean coal technologies in those regions of the globe that are looking to energy from coal to assist in economic development, we also might best ensure that emissions from using coal will be effectively controlled and because of greater efficiencies, these technologies could also help to minimize carbon dioxide releases, a suspected agent of climate change.

Subsection (d) requires the Council to cause to be established within existing agencies certain financial and technical assistance programs designed to encourage the use of clean coal technologies particularly in lesser developed countries. (Subparagraph (d)(3) vests within the Council what may be direct authority to establish financial incentive programs rather than rely upon the existing authority of other departments or agencies; however, if this be the case, then it is recommended that these authorities be more fully defined.)

The Coalition supports the various enumerated duties designated for the Council, but it is not clear how the Council might proceed with undertaking these enumerated duties nor how the Council could achieve the results implied by the duties set forth. Without direct authorization or administration over specific programs, the Council may not be able to persuade specific agencies to undertake programs of support for encouraging clean coal technology projects especially where an agency, in the administration of a particular program, either may be required to maintain neutrality or may have adopted a policy of non-preferential treatment as between various types of energy projects or energy resources to be supported.

The Committee may wish to consider vesting within the Council, notwithstanding any other provision of law, the authority to direct departments or agencies to use their existing authorities to accomplish -- but not be limited to -- the following:

- o require trade missions supported by the Agency for International Development and well as commercial and energy attaches at United States embassies to be knowledgeable about clean coal technologies for purposes of providing information to foreign governments or potential project sponsors in those countries;
- o undertake educational programs directed toward understanding clean coal technologies, including the environmental benefits of using such technologies, for personnel of the World Bank involved in the financing of energy projects;
- o increase the understanding of clean coal technologies by representatives of foreign companies or countries intending to use coal through augmented training programs and workshops conducted in the United States for such foreigners;
- o augment existing budgets or seek expanded budgets for U.S. trade and development programs or programs supported by AID's energy office in order to financially support pre-feasibility and feasibility studies for projects that will utilize clean coal technologies; and
- o aggressively utilize existing loan guarantee authorities and grants or no or low interest loans to facilitate access to capital markets or to reduce financing costs of a clean coal project once selected.

Subsection (e) of section 5004 requires the Council to provide a country-by-country assessment of the potential for use of clean coal technology. Such information, if based upon a realistic assessment of the potential markets, could be of great value to U.S. industry in attempting to determine the location of markets for clean coal projects or equipment.

These country-by-country assessments should also include some analysis regarding the character of the market needs, that is, simply identifying needs for power is not sufficient. The

Council should include in such assessments answers to questions such as: Is the potential market for the clean coal technology dependent upon financing; is coal competing with other energy resources; are environmental considerations a priority in powerplant technology selection; and, how technically sophisticated are those personnel who are likely to be involved in planning for or operating the power facilities?

The Council should also be directed to undertake an analysis of what foreign competitors are doing to enter or control those foreign markets for which assessments are undertaken. Other governments provide very significant incentives, including no interest loans or other concessions, which enable foreign competitors to provide very favorable financing packages for power projects. We understand that these financing packages currently cannot be matched by U.S. industries.

If the United States is to acquire and retain world markets for the use of clean coal technologies then it is important to address the financing requirements of clean coal projects and the role which government might play in supporting the financing of such projects. The Council to be created by section 5004 should be specifically charged with identifying how U.S. industry, with the support of the federal government and through our existing foreign aid and commercial export programs, might be better able to compete in the world market and what types of support should be authorized to best enable U.S. industry to compete in the forthcoming global clean coal market.

C. Other Suggested Amendments to S.341

The Clean Coal Technology Coalition also strongly endorses section 5101 of the bill which would clarify the application of the so-called "WEPCO" decision to permanent clean coal retrofit projects.

This amendment, and we understand another perfecting amendment to be offered by Senator Johnston when the bill is considered in the Committee for mark-up, would provide a permanent clean coal "retrofit" project with an exemption from Parts C and D of title I of the Clean Air Act so long as such project is undertaken for pollution control purposes and does not result in an increase in potential emissions of a specific regulated pollutant.

Congress, in enacting the Clean Air Act Amendments of 1990, specifically exempted temporary clean coal projects (those that will be demonstrated for five years or less) and permanent clean coal technology **repowering** projects from provisions of the existing Clean Air Act. Clean coal **retrofit** projects which are intended only to control emissions should be afforded these same

exemptions. Section 5101 would provide for these exemptions and the Coalition urges adoption of this provision.

The Coalition also wishes to apprise this Committee of a potential problem with implementation of certain provisions of the Clean Air Act Amendments of 1990 with regard to exemptions provided for "temporary" and "permanent repowering" clean coal demonstration projects.

With the assistance of a number of Members of the Senate Energy and Natural Resources Committee, several provisions were included in the Clean Air Act Amendments of 1990 that might benefit clean coal projects that are supported currently under the on-going clean coal technology demonstration program. These provisions, which are more fully described in attachment 4 to this written statement, provide DOE and EPA-supported clean coal projects with enumerated exemptions from provisions of the Clean Air Act.

We believe that Congress intended for these provisions to be "self-executing" and that any qualifying DOE or EPA-supported clean coal project should be automatically exempt from the statutorily identified provisions. Any delay in implementation of the exemptions will simply mean that the exemption provisions cannot be utilized because these clean coal projects are already obligated under the demonstration program to certain milestone dates. Now, we are advised that the EPA may require the filing of an application for an exemption and that the EPA will then undertake an examination of the relative merits of granting the exemptions. While the EPA seeks to scrutinize the various clean coal projects, the projects are required to proceed, with or without benefit of the exemptions. This type of delay was surely not intended by the Congress.

The Coalition would also recommend that the Committee consider two additional amendments to the provisions of S.341. These include the following:

1. **Modification of the Public Utility Regulatory Policies Act (PURPA) to ensure that the rates provided a DOE clean coal demonstration project would not be included in the calculation of avoided cost.**

2. **Direction to the Secretary of Energy to report to the Congress within a time certain on those actions taken by the DOE, as described in the National Energy Strategy, to encourage states to adopt favorable regulatory treatment of clean coal technology expenditures and to assess the effectiveness, after a time certain, of such initiatives by the DOE.**

With respect to the amendment to PURPA the Coalition would propose the addition of a new section 5103 to read as follows:

> "SEC. 5103. Section 210 (d) of Public Law No. 95-617 is amended by inserting at the end the following:
>
> > "but shall not included any cost reasonably identified to be incurred or to have been incurred in the construction or operation of a facility or a project which has been selected by the Department of Energy and provided federal funding pursuant to the Clean Coal Technology Program authorized by Public Law No. 98-473."

The cost of power from a clean coal demonstration project could be high because the risk factor associated with a first-of-kind project will require that the project's cost be increased as a result of equipment redundancies and other over-engineering measures incorporated to ensure reliability and minimize risk. This accommodation for risk could significantly increase the cost of the project. Also, these projects may not be of optimum size which might also influence the cost of the project.

A utility participating in the clean coal demonstration program might be required to seek a rate to recover investment in the clean coal project that could also become the benchmark for calculating a high avoided cost. If avoided cost is driven higher by a clean coal project, then the utility may be required subsequently to offer others that higher rate, caused in part by the cost of the clean coal project.

Alternatively, if the rate is high, others including independent power producers who may compete to provide power to the utility demonstrating the clean coal technology, could argue that electricity can be delivered at a less expensive rate and therefore the clean coal project should not be constructed.

The requirements imposed upon utilities by PURPA should not be made an encumbrance to a utility's willingness to demonstrate a clean coal technology. The amendment we recommend would simply exclude a DOE clean coal demonstration project from the avoided cost calculation.

Finally, the Coalition would propose the addition of a new section 5104 to read as follows:

> "SEC. 5104. Report to Congress Upon Progress for Encouraging State Adoption of Regulatory Incentives. -- The Secretary, in carrying out that provision of the National Energy Strategy which seeks to encourage state regulatory authorities to provide regulatory incentives for utilities to invest in projects using innovative

> clean coal technologies, shall report to the Congress within 365 days after submittal to the Congress of the National Energy Strategy upon programs initiated to encourage such state action. Further, the Secretary shall describe those regulatory incentives that have been adopted by states as a result of the actions taken by the Secretary."

The Coalition agrees with statements included in the National Energy Strategy which note that the adoption of regulatory incentives at the state level could greatly enhance the prospects for use of clean coal technologies by utilities. As a part of the National Energy Strategy, the Secretary of Energy is committed to encourage states to adopt such regulatory incentives. The amendment proposed by the Coalition would require the Secretary to report to the Congress upon the progress made in seeking to encourage states to adopt such incentives.

CONCLUSIONS

The Coalition generally supports those provisions of S. 341 which address clean coal technologies. The amendments recommended in this statement would be important perfecting amendments or additions to help further the development and use of these important technologies.

CLEAN COAL TECHNOLOGY COALITION

MEMBERSHIP

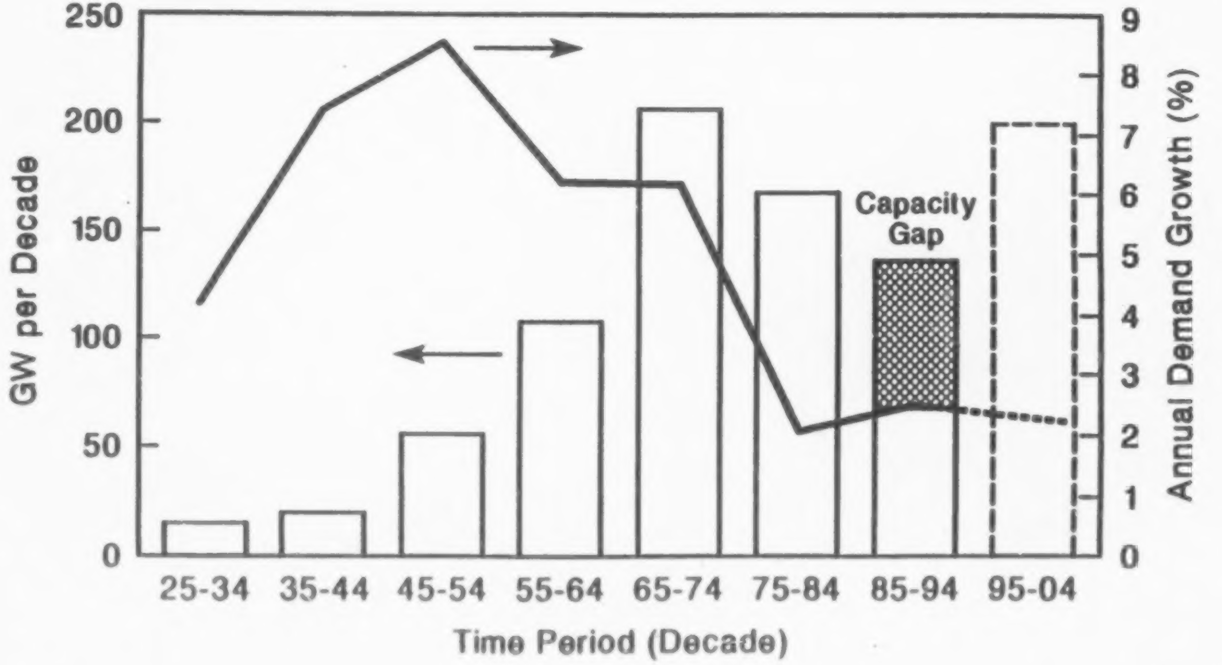
March 8, 1991

A.T. Massey Coal Company, Inc.
Alabama Coal Association
Allison Gas Turbine Division, General Motors Corporation
AMAX Coal Industries
American Electric Power Service Corporation
American Mining Congress
Arch Mineral Corporation
Asea Brown Boveri, Inc.
Ashland Coal, Inc.
Babcock & Wilcox
Baltimore Gas & Electric Company
Bechtel Power Corporation
Bethlehem Steel Corporation
Brigham Young University
Carbon Fuels Corporation
Carolina Power & Light Company
Centerior Energy
Central Illinois Public Service Company
Cincinnati Gas & Electric Company
Combustion Power Company
Consolidation Coal Company
Cyprus Coal Company
Deutsche Babcock Werke, AG
Duke Power Company
Ebara Environmental Corporation
Edison Electric Institute
Fluor Corporation
General Electric Company
General Public Utilities, Inc.
Geneva Steel
Illinois Power Company
Indiana University
Indianapolis Power & Light
Jersey Central Power & Light Company
Marietta Coal Company
Metropolitan Edison Company
MHD Development Corporation
Montana State University
Morrison-Knudsen Corporation
National Coal Association
National Lime Association

ATTACHMENT 1

Northern Indiana Public Service Co. (NIPSCO)
Ohio Edison
Ohio Mining and Reclamation Association
Ohio Clean Fuels, Inc.
Oklahoma Gas & Electric Company
Orange and Rockland Utilities, Inc.
Passamaquoddy Technology
Peabody Holding Company, Inc.
Pennsylvania Electric Company
Pennsylvania Power & Light Company
Pittsburg & Midway Coal Mining Co.
Public Service Company of Colorado
Public Service Company of Indiana
Public Service Electric and Gas Company
Sargent & Lundy Engineers
South East Coal Company
Southern Company Services
Southern Illinois University at Carbondale
Southern Indiana Gas & Electric Company
Stone & Webster Engineering Corporation
Texaco, Inc.
The Commonwealth of Kentucky
The State of Alabama
The State of Colorado
The State of Illinois
The State of Indiana
The State of Ohio
The State of Texas
The State of West Virginia
TransAlta Utilities Corporation
Union Electric Company
United Coal Company
School of Mines and Energy Development, University of Alabama
University of Missouri-Columbia
University of Montana
University of Southern Indiana
University of Tennessee
University of Wyoming
Western Research Institute
West Virginia University
Wisconsin Power & Light Company
Wisconsin Public Service Corporation
Zeigler Coal Company

U.S. CAPACITY VS DEMAND GROWTH



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Source: Electric Power Research Institute

ATTACHMENT 2

SO2 AND CO2 EMISSION COMPARISON OF CONVENTIONAL AND CLEAN COAL TECHNOLOGIES

This chart provides a comparison of the sulfur dioxide (SO2) emissions that a utility steam generating facility would emit if it used a conventional pulverized coal boiler (with a thermal efficiency of about 33 percent) and a wet scrubber system (achieving a 90 percent reduction) against several of the clean coal technologies which are expected to operate at higher efficiencies and remove well above 90 percent of the uncontrolled SO2 emissions from the unit. The SO2 emission levels are calculated for a 500 MW facility (i) burning coal with a 2 percent sulfur content and a heating value of 12,000 Btu's per pound of coal, and (ii) operating at a 65 percent capacity for a 30-year period. A similar comparison is provided for carbon dioxide generated at each facility.

Technology	Plant Capacity (Megawatts)	% SO2 Removal (Percent)	Plant Efficiency (Percent)	Plant Heat Rate (Btu/kwh)	Ann. SO2 Emissions (Tons)	30-Year SO2 Emissions (Thousand Tons)	Ann. CO2 Emissions (Million Tons)	30-Year CO2 Emissions (Million Tons)
PCB with Scrubber	500	90	33.0	10331.9	4902.5	147	3.0	90
AFBC	500	90	36.0	9470.9	4493.9	135	2.8	84
	500	90	37.0	9214.9	4372.5	131	2.7	81
PFBC	500	95	40.0	8523.8	2022.3	61	2.5	75
	500	95	45.0	7576.7	1797.6	54	2.2	66
IGCC	500	99	40.0	8523.8	404.5	12	2.5	75
	500	99	42.0	8117.9	385.2	12	2.4	72
	500	99	48.0	7103.2	337.0	10	2.1	63
IGCC with Fuel Cells	500	99	50.0	6819.1	323.6	10	2.0	60
	500	99	55.0	6199.1	294.1	9	1.8	54
MHD	500	99	50.0	6819.1	323.6	10	2.0	60
	500	99	55.0	6199.1	294.1	9	1.8	54
	500	99	60.0	5682.6	269.6	8	1.7	51

PCB - Pulverized Coal Boiler

AFBC - Atmospheric Fluidized Bed Combustion

PFBC - Pressurized Fluidized Bed Combustion

IGCC - Integrated Gasification Combined Cycle

MHD - Magnetohydrodynamics

ATTACHMENT 3

Final Language of Key Clean Coal Technology Provisions

Issue	Final Language	Clean Coal Technology Implications
1. Technologies Eligible for "Repowering" Incentives	SECTION 402(12) The term "repowering" means replacement of an existing coal fired boiler with one of the following clean coal technologies: atmospheric or pressurized fluidized bed combustion, integrated gasification combined cycle, magnetohydrodynamics, direct and indirect coal fired turbines, integrated gasification fuel cells, or as determined by the Administrator, in consultation with the Secretary of Energy, a derivative of one or more of these technologies, and any other technology capable of controlling multiple combustion emissions simultaneously with improved boiler or generation efficiency and with significantly greater waste reduction relative to the performance of technology in widespread commercial use as of the date of enactment of the Clean Air Act Amendments of 1990. Notwithstanding the provisions of Section 409(a), for the purpose of this title, the term "repowering" shall also include any oil and/or gas fired unit which has been awarded clean coal technology demonstration funding as of January 1, 1991, by the Department of Energy.	• The definition of "repowering" can be interpreted to provide that these multi pollutant technologies designated by the EPA Administrator may qualify for the repowering incentives without replacement of a coal-fired boiler. This interpretation needs to be made explicit during EPA rulemaking. • Providing multi pollutant control technologies with the "repowering incentives" is consistent with the President's market-based approach to control of air emissions and Secretary of Energy Watkins' letter to Congressman Regula which establishes that the House and Senate intended multi pollutant technologies qualify for the incentives.
2. Eligibility of "Greenfield" Replacement Units;	SECTION 409(a): The replacement of an existing utility unit with a new utility unit using a repowering technology referred to in section 402(2) which is located at a different site, shall be treated as repowering of the existing unit for purposes of this title if-- "(1) the replacement unit is designated by the owner or operator to replace such existing unit, and "(2) the existing unit is retired from service on or before the date on which the designated replacement unit enters commercial operation.	• This provision will help to ensure the more rapid and widespread commercialization of the clean coal repowering technologies, by providing utilities with the flexibility to repower or replace an existing facility with such a qualifying technology at a new facility. • The conference agreement eliminated the burdensome requirement that the replacement unit be sited in the same air quality control region as the existing unit.
3. Extension of Phase II Compliance Deadline;	Senate Section 409(b)(1) is adopted without modification.	
4. EPA Forebearance if Technology Proves Infeasible;	409(b)(2): If (A) the owner or operator of an existing unit has been granted an extension under paragraph (1) in order to repower such unit with a clean coal unit, and (B) such owner or operator demonstrates to the satisfaction of the Administrator that the repowering technology to be utilized by such unit has been properly constructed and tested on such unit, but nevertheless has been unable to achieve the emission reduction limitations and is economically or technologically infeasible, such existing unit may be retrofitted or repowered with equipment or facilities utilizing another clean coal technology or other available control technology.	• This provision recognizes that use of first-of-a-kind technologies in commercial-scale application involves great risk; to compensate and provide incentive for risk taken, a time extension is authorized where it is determined that the clean coal technology will not achieve sought-after and planned goals. • Final language needs to be clarified during rulemaking to ensure that the technology does not need to be installed and subsequently abandoned in order to continue to receive the extension of time.

ATTACHMENT 4

Issue	Final Language	Clean Coal Technology Implications
5. "WEPCo Fix" for Repowered Sources:	SECTION 409(d): Any unit qualifying for an extension under this section that does not increase actual hourly emissions for any pollutant regulated under the Act shall not be subject to any standard of performance under Section 111 of this Act.	• This provision will help to ensure that emerging clean coal technologies will be a viable compliance option for utilities during Phase II by providing relief from EPA's current WEPCo interpretation of its NSPS regulations.
6. "WEPCo Fixes" for Clean Coal Demonstration Projects:		
• Temporary Projects:	Senate Section 415(b)(2) is adopted without change.	• WEPCo exemption applies to temporary clean coal projects (i.e. less than five years in operation) that have received funding from the DOE to commercially demonstrate emerging clean coal repowering or retrofit technologies.
• Permanent Repowered Projects:	SECTION 415(b)(3): For permanent clean coal technology demonstration projects that constitute repowering as defined in section 402(l) of this title, any qualifying project shall not be subject to standards of performance under section 111 or to the review and permitting requirements of part C for any pollutant the potential emissions of which will not increase as a result of the demonstration project.	• These exemptions from the Clean Air Act would provide a "WEPCo fix" for DOE or EPA-funded clean coal repowered projects and thus provide a very important incentive for these government/ industry cost-shared projects. • This language should provide qualifying repowering projects with a potential-to-potential emission comparison, on a pollutant-by-pollutant basis.
• Permanent Retrofit Projects:	Senate provision is not included in the bill.	• Senate WEPCo fix was eliminated because it did not provide relief from EPA's WEPCo policy.
7. Limitation of Funding:	House funding limitation is not included in the bill.	• DOE clean coal program funding remains available to both utility and non-utility participation, in all geographic regions of the country and to all types of coal. This broader application of the program funds will result in the greatest national benefits.

Senator **Wallop** [presiding]. Thank you, we appreciate your statement.

Mr. Yeager, yours is next.

And as we asked Mr. Yamagata, if you could summarize, but having read your statement in its entirety, I hope in your summary you do not overlook the principal positions that you take about how we are short-cutting our future by short-term fixes of convenience in the present.

STATEMENT OF KURT E. YEAGER, SENIOR VICE PRESIDENT, TECHNICAL OPERATIONS, ELECTRIC POWER RESEARCH INSTITUTE

Mr. **Yeager**. Thank you, Mr. Chairman and members of the subcommittee.

I am Kurt Yeager, senior vice president for technical operations of the Electric Power Research Institute. And I appreciate this opportunity to testify on the continued development and use of advanced technology for our nation's and the world's dominant fuel resource, coal.

We believe this issue is particularly significant because coal technology is one of the most important areas where the United States can act to improve its long-term competitive position.

Mr. Chairman, with your permission, and in light of the time limitations, I would like to summarize my testimony in terms of the following conclusionary points.

First, the United States should be preparing for at least a doubling in coal use as our primary domestic energy resource over at least the next 50 years. Even sharper international growth is anticipated.

The challenge is not whether coal will be used, but how to assure its most efficient utilization and minimal impact on the environment.

Second, innovative, clean coal technology provides the means to resolve the conflicts between coal use and the environment, while protecting U.S. competitiveness in the global market place.

We believe this is particularly important because of the probability that coal will surpass petroleum as the world's primary energy source by early in the 21st century, and I am pleased that the United States electric utility industry has committed some $5 billion over the past decade alone to the success of this national initiative.

Third, the United States is not likely to play a major role, regrettably, in this, what has been characterized as a $50 billion per year, I think it is considerably more than $50 billion a year, technology market, unless our short-term oriented, risk-averse national investment, trade and environmental policies are changed to encourage what I would characterize as a national arsenal of energy innovation.

Success will depend both on transforming technological advances into high quality U.S. products, and trade policies that really reinforce our competitiveness by encouraging strategic investment opportunities, particularly in the developing work and Eastern

Europe where economic progress is going to depend on electrification through coal.

Fourth, sustained competitiveness through innovation will require a better linkage of government and private resources, not just to the development, but to the deployment of commercial products, including higher technical quality standards; technological training; better education for all our citizens.

Policies are going to have to be altered to encourage sustained, long-term investment in improved skills and facilities necessary to advance the creation, production and use of technology.

Fifth, this is going to require a change in public perception and policy, one that mandates the same sustained national commitment to reinforcing the U.S. advantages in resources, particularly coal and technology, similar to the accomplishments that have marked our military power leadership over the past 50 years. National security can no longer be viewed exclusively in military terms.

Six, for example, the United States has the unique advantage in being able to phase out its imported oil dependence in favor of indigenous resources. This is likely to be an exceptionally important international business advantage, while protecting political cooperation from the stress of competition for dwindling resources.

As I result, I think it is not too far of a stretch of the imagination to consider that U.S. coal may prove to be as important to protecting the Western alliance during the next 50 years, as the U.S. military umbrella has been during the past.

It is therefore particularly disappointing that the proposed national energy strategy does not reflect this vision of coal's importance, either to our international relationships or our domestic economy.

Seven, if political impatience on environmental issues is allowed to continue to dominant our policy process, we are going to waste enormous resources and commercial opportunities while actually increasing environmental risk.

Eight, as the focus of public perception moves to the global stage, and after the fact, end-of-pipe environmental clean-up becomes increasingly unsupportable, harnessing energy efficiency improvement to prevent pollution becomes essential.

I believe the central policy theme in the coming decades is going to be how to balance the world's expanding population and its economic aspirations against a finite resource base which will include the environment.

I believe coal provides the United States a unique resource and technological opportunity to demonstrate its leadership in achieving a sustainable global development.

Nine, a coal refining approach to provide a variety of products, including at least 50 percent higher efficiency electricity, provides both much higher energy productivity as well as energy security, environmental protection and global competitiveness.

I believe this will be the basis for the world class power plant capable of best addressing the interdependent economic and environmental challenges of sustainable global development.

It is the essential technological building block for an energy strategy addressing the realities of the coming decades and it is within our grasp today.

And finally, fortunately, I believe the United States remains a technological and commercial leader for the gas turbine, fuel cell, coal conversion and silicon microprocessor technologies, essential to this least-cost refining approach to power production and a coal-based national energy economy.

The issue remaining is not technological in my judgment, but the national patience and focused, proactive will to encourage this technological transformation.

If we are successful, this transformation can be both the foundation for rebuilding American and the U.S. lead global arsenal of coal and electricity-based energy innovation powering the new century.

Thank you very much.

[The prepared statement of Mr. Yeager follows:]

Testimony
by

Kurt E. Yeager
Electric Power Research Institute

to

U. S. Senate
Committee on Energy and Natural Resources
Subcommittee on Energy Research and Development

Washington, D.C.
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INTRODUCTION

Chairman Ford and Members of the Subcommittee: I am Kurt E. Yeager, Senior Vice President for Technical Operations, of the Electric Power Research Institute. I appreciate this opportunity to testify on the continued development and use of advanced technology for our nation's, and the world's, dominant fossil fuel resource - coal. This issue is particularly significant because coal technology is one of the most important areas where the United States can act to improve its long term competitive position. The U.S. electric power utility industry, for example, now consumes 80 percent of the one billion tons of coal produced in the U.S. annually to generate 55% of the nation's electricity. It is the primary fuel because of its low cost and wide geographic availability. By 2010, it is likely that coal production will increase to at least 1.5 billion tons per year as total installed generating capacity increases from less than 700,000 MW's to about 900,000 MW's.

EPRI was established by the electric utility industry in 1972 to conduct a broad research and development program for the entire electric utility industry and its ratepayers. EPRI's R&D mission is to develop new and improved technologies for electric power production, delivery and use, and to help accelerate their availability insuring an adequate supply of economic, reliable and environmentally acceptable electricity.

EPRI is supported by voluntary contributions from investor-owned, government-owned and cooperatively-owned electric utilities across the nation. Nearly $5 billion are being invested by the electric utility industry and EPRI on the development and demonstration of Clean Coal Technology. This commitment is based on the premise that coal utilization and environmental protection are mutually compatible and that improved technology is the key to compatibility. We are particularly pleased that these efforts have become the backbone of the national Clean Coal Technology demonstration joint venture -- bringing the private and public sector together to accelerate the commercial availability of this new technology base for coal.

The United States has historically been the global wellspring for coal utilization technology. As a result, the large majority of coal-fired power plants in the free and developing world have relied on technology provided by, or licensed from, U.S. developers and manufacturers. It is this technical leadership which has sustained the industry's competitiveness in the face of many economic and policy hurdles. This leadership is increasingly challenged, however, by nations which encourage a more cooperative relationship between industry and government coupled with national energy policies which maintain focus on the strategic importance of coal and the technologies for its use. At risk are not only international markets but U.S. competitiveness in our own domestic marketplace.

As the focus of public perception on environment issues moves to the global stage, efficiency improvement to prevent pollution becomes the most practical means to address the interactive, global, core resource issues. Auxiliary emission and effluent controls are eliminated wherever possible, either by avoiding formation of the pollutants or through more efficient process integration with coal-based power production.

A major result of this new attention is recognition that coal-based power plants are rapidly evolving away from the historic boiler-turbine-generator configuration toward integrated resource processing facilities, whether the prime technology is pulverized coal, fluidized combustion, or coal gasification-combined cycle which are now available or gasification-fuel cell technology which could be demonstrated by the end of this decade. The coal gasification based technologies lead to heat rate and emissions control efficiency progress by elimination of the steam cycle. The concept of "electricity without steam" is a technological leap that is within our potential to achieve within the next decade.

The ultimate result can be the transformation of coal-fired power plants from relatively resource inefficient combustion units into fully integrated coal refineries. This can be the basis for the "world class" power plant capable of best addressing the interdependent economic and environmental challenges in our future. Adopting this refining approach to coal utilization for electricity, transport fuel, and chemical feed stocks would be an important element of a technological strategy to concurrently process the total value of our nation's indigenous coal as well as its urban and biological waste resource into an array of products, including electricity.

We are optimistic that coal, which ushered in the electric age 100 years ago, can be poised to meet the challenges of the Twenty-First Century. Whether this goal will be achieved, however, depends on a renewed national commitment to leadership, not just in coal R&D but effective translation of the results into commercial reality on a global scale.

My remarks are intended to put this issue in better perspective and will address the following topics:

- Electricity and Coal
- Advanced Coal Technology
- The Role of the United States
- National Energy Implications

ELECTRICITY AND COAL

First and foremost, it can be confidently predicted that providing for future growth in electricity supply and assuring that electricity is used efficiently will continue to be inseparable from achievement of the nation's economic prosperity in a globally competitive market. During the economic expansion since 1982, electricity growth has paralleled GNP growth while real electricity price has declined 16% and overall energy efficiency has improved 11%. Continued productive improvement in energy efficiency through electrification means that the rate of increase in primary energy consumption is expected to shrink, by 2010, to less than half the annual rate of U.S. GNP growth (1). As these figures indicate, economic progress, energy efficiency and increased electrification have proceeded hand-in-hand, and continued economic growth is expected to raise electricity use to nearly 50% of U.S. energy consumption by the turn of the century (2).

It is also likely that electricity's role in the U.S. (and world) energy economy will continue to grow as dramatically during the next 50 years as it has during the past 50 years. This is based on emerging, environmentally-related, market opportunities where electricity offers unique advantages.

As we enter the Second Electrical Century, this growth business of electricity will continue to depend, as it did in the First, on low-cost energy from coal. Coal use most certainly must be aggressively joined by a nuclear renaissance and promising new resource opportunities essential to a sustainable energy future. Even then, it is likely that coal will continue to produce at least half the nation's electric power through the middle of the next century and, in so doing, act as the bridge to that sustainable future. This forecast is based on the importance of coal as the primary domestic energy source during this period.

Based on examinations of U.S. energy use patterns that consider alternative economic, social, energy availability, environmental, and technological scenarios, we should be preparing for at least a doubling of coal use and an increase in its share of total U.S. energy consumption from today's 26 percent to about 40 percent over the next 50 years (3). Notably, 1990 marked the year in which the U.S. first reaches an annual coal production rate of one billion tons. Thus, the challenge is not whether coal will be used but how to assure its most efficient utilization and resulting lessened impact on the environment. This will be essential to the concept of sustainable global economic and environmental development in the Second Electrical Century.

The importance of the technological linkage between electricity and coal on a global scale is underscored by the Conservation Commission of the World Energy Conference (4) which projects that:

- Future global economic growth, particularly in the developing regions, will be associated with very large increases in electricity growth.

- Coal, which provides over 80% of the world's non-renewable energy resource, will become increasingly prominent in the coming decades. Worldwide, coal usage is expected to exceed the use of petroleum during the first decade of the next century and to continue its preeminence during at least the following fifty years.

- Technological innovation to support this expansion in coal use will be essential for the world's environment and its economy.

- The geopolitical importance of coal is also likely to increase since the world's coal resource is predominantly controlled by three nations: the U.S., China, and the USSR. It does not take too much imagination to conceive that the relationship of the latter two with their economically dominant neighbors, Japan and W. Europe, is likely to increasingly be a focus of global energy policy in the coming decades.

Proven global reserves of fossil fuels other than coal (i.e., resources which can be recovered economically under local conditions using existing technologies) are likely to be consumed by the end of this decade (4). That reality will place escalating cost pressure on the use of additional non-coal energy. Escalation is likely to be capped by the cost of producing synthetic fuel from coal and oil shale, assuming our policies encourage that development. This energy consumption versus resource comparison also underscores the need for accelerated, safeguarded, breeder reactor development which could extend the limited uranium resource by a factor of 60. Similarly, the urgency of pursuing renewable energy technology is clear if the developing world in particular is to move beyond what is likely to become an overwhelming dependence on coal after the first half of the 21st century.

ADVANCED COAL TECHNOLOGY

The changes in technology for coal utilization, are being driven primarily by the need to reduce the cost of complying with ever-increasing environmental requirements. As a result, the environmental performance criterion in power plant design is being raised to a level equivalent with the classical engineering criteria of thermal efficiency and reliability, and is being integrated into power generation technology accordingly. Since 1970, the U.S. has increased its use of domestic coal by 90 percent while achieving a 28 percent reduction in sulfur dioxide (SO_2) emissions. SO_2 emissions from electric utilities, which use eight out of every 10 tons of coal consumed domestically, have decreased at a median rate of about four percent per year, for an overall reduction of 37 percent. This trend is being extended through the "Clean Coal Technology Initiative". This initiative is bringing a variety of innovative technology options for coal-based power generation into serious commercial consideration after decades of relative technological stagnation (5).

These new options are all intended to provide opportunities to resolve the historic conflicts between coal use and the environment. These conflicts are reflected in the fact that environmental protection costs have typically risen to more than 35% of the investment for a conventionally designed and constructed, coal-fired, power plant.

As a result of these innovative clean coal technology options, the electric power industry stands at a threshold of change in its technological base for coal-fired power generation which can better meet the environmental performance criterion.

The principle which guides this more innovative clean coal technology development is that sustained environmental improvement can only be achieved when both emission and cost reduction are achieved concurrently, not pitted against each other. The results provide a unique opportunity to concurrently satisfy two national goals: (a) continue the substantial progress made in emission control and (b) meet the rapidly approaching electricity generating capacity challenge with reduced cost and increased productivity.

A major result of this attention is recognition that coal-based power plants are rapidly evolving away from the historic boiler-turbine-generator configuration and toward integrated resource processing facilities, whether the prime technology is pulverized coal, fluidized combustion, or coal gasification-combined cycle.

As the focus of public perception moves to the global stage, and the cost-effectiveness of after-the-fact cleanup becomes increasingly unsupportable, harnessing efficiency improvements to prevent pollution becomes essential as the only practical means to address the interactive, global, core resource issues. This process becomes increasingly urgent under the pressures of economic development, urbanization and population growth. This combination has reached the point where mankind has the capacity to impact the global biosphere. As a result, short-term adaptation to, and longer-term mitigation of, this growing impact is likely to dominate the environmental priorities of the 21st Century. The central policy theme will be how to balance the world's expanding population and economic aspirations against a finite resource base, including the environment.

Fortunately, innovative technology through electricity can respond to substantially reduce the amount of energy required to provide a given level of goods and services while simultaneously reducing environmental impact. On the supply side, adopting a high efficiency refining approach to coal utilization for electricity, transport fuel, and chemical feed stocks would be an important element of such a technological strategy. It would serve to concurrently process the total value of a nation's indigenous coal as well as its urban and biological waste resource into an array of products, including electricity. This would provide the foundation for both continued economic development and environmental protection, including reducing global CO_2 production by one-third over the next 50 years.

Unfortunately the U.S. policy response to environmental risk minimization remains focused on short-range, after-the-fact, "end-of-the-pipe" clean-up expediencies rather than incenting innovative technologies and practices which reduce pollutant formation. The resulting economic impact is large. For example, the U.S. now spends about $80 billion per year to meet federal environmental control requirements with less than one percent directed to pollution prevention (6). The immediate impact of the 1990 Clean Air Act Amendments will further extend this unproductive situation with no greater emphasis on pollution prevention or efficiency.

The international nature of the Clean Coal Technology Initiative is reflected by the nearly 100 demonstrations underway both in the U.S. and overseas (7). This international attention is driven by a growing, world-wide, clean coal technology market valued at about $80 billion per year by 2000. This market is expected to remain relatively stable in value well into the 21st Century. Table 1 summarizes the basis for this market resulting from the expected global expansion in coal utilization for electric power production.

Table 1

Coal -Fired Generating Capacity Growth

	1990 Installed Coal Capacity (GW)	Expected Coal Growth 1990-2000		Expected Coal Growth 2000-2020	
		%/Yr	New GW	%/Yr	New GW
N. America	340	1.0	30	2.0	180
W. Europe, Japan, Australia	220	2.0	40	1.5	100
E. Europe, USSR	250	1.1	30	1.5	100
China, India, Africa	200	1.3	30	2.0	110
Pacific Rim, S. America	60	7.5	60	4.7	190
TOTAL	1040		190		680

Thus, total coal-fired generating capacity world-wide is expected to nearly double over the next 30 years. Essentially all this new capacity will be a candidate for innovative clean coal power generation technology. The U.S. is not likely to play a main role in this market, however, unless our short-term oriented, risk averse national environmental, technology, trade and investment policies are changed to encourage innovative leadership nationally and globally.

THE ROLE OF THE UNITED STATES

The U.S. is best served by focusing on innovative technological opportunities to regain international industrial leadership and competitive advantage. Success will depend on transforming technological advancements -- wherever they may be discovered around the globe -- into high-quality U.S. products, coupled with more strategic trade and investment policies which level the international market playing field, particularly in the developing world.

U.S. international competitiveness is central to our national strategy and influence in the decades ahead. In the future, the traditional approach to foreign policy will have to give more serious consideration to strategic industrial issues, such as the strength of the U.S. manufacturing base and the leverage of key technologies across industries. This shift in focus will require a reassessment of both the priorities that govern foreign policy and the government institutions that are involved in the policy making process. National security can no longer be viewed exclusively in military terms; economic security must be taken into account. This will necessarily have an impact on the management of international relations, since important political allies are often hard-nosed economic competitors in commercial technology (8).

It has been fashionable to consider U.S. manufacturing as synonymous with moribund industries that had more to do with America's industrial past than its high-tech future. It is now becoming recognized again that a strong manufacturing base is essential to leading-edge industries as well as to mature industries, and that technological and commercial "food chains" connect so-called low-tech and high-technology industries. Moreover, mastery of the manufacturing process is increasingly viewed as an essential part of the technical competence that is necessary to advance existing technologies and create new ones.

Fortunately, the U.S. still remains a technological and commercial leader for the higher value-added gas turbine, fuel cell, coal conversion, and silicon micro-processor technologies, all essential to a least cost, refining approach to power production and a coal-based national energy economy. These technologies provide incentives for U.S. corporate innovative and commercial leadership because their advantages in the global marketplace have, so far, been sufficient to offset the deficiencies of U.S. trade, tax and commercial collaboration policies. For example, leadership in gas turbine and other post-Rankine steam cycle energy conversion technology, such as fuel cells, reflects U.S. leadership in defense and aeronautics technology. Coal conversion technology results from strategic R&D investments by the petroleum and chemical industries which control the bulk of U.S. coal resources and are culturally and technically familiar with a chemical processing approach to resource utilization. Finally, microprocessor technology is a powerful and rapidly expanding result of the $400 billion per year, U.S. electronic industry, where 20% of all U.S. industrial research is conducted.

Paradoxically, it is these three relatively robust technological foundations, not now dependent on the power or coal industries, that will become increasingly important to U.S. coal and power generation, assuring both their competitive future and that of the nation to whose prosperity they are so closely tied. When combined, they provide the means to break the steam cycle efficiency barrier for coal-based electric power production with an impact similar to that of jet aircraft on the sound barrier and air travel 40 years ago. The ultimate result can be the transformation of coal-fired power plants from relatively resource inefficient, combustion units into fully integrated coal refineries. This can be the basis for the "world class" power plant capable of best addressing the interdependent economic and environmental challenges pacing the 21st Century. The U.S. is poised through its combination of technology and coal resources to provide world leadership for this transformation. The payoff is not just commercial advantage but resource conservation and environmental protection on a global scale.

Invention will not be enough, however. Sustained competitiveness through innovation also will require a better linkage of government and private R&D funding to the productivity of commercial products; strengthening the manufacturing base; the establishment of, and commitment to, higher technical quality standards; investment in the technological training of workers, and a better basic education for all citizens (9). Policies will have to be altered to encourage sustained, long-term investment in improved skills and facilities necessary to advance the creation and use of technology. This is necessary to encourage long-term global market development and to promote innovative commercial leadership, increasingly dependent on collaborative R&D.

The current environment of increased international corporate flexibility in the quest for economic advantage encourages these collaborative, national, enterprises that focus public and private resources and risk-sharing for advantage in attracting and building the corporate economic base. This strategy of establishing national "arsenals of innovation," is already being exploited successfully by other nations. Their importance to the U.S. may be as much in building the new relationships among businesses, universities and the government necessary to compete internationally, as in actually creating technological innovations (8). Underpinning all of these steps is the need for a greater sense of personal responsibility for the future and a more cooperative, less adversarial, approach by both the public and private sectors to marshalling our unmatched national capabilities.

An important driving factor is underscored by the February 1991 National Energy Strategy (10). This strategy, unless changed to emphasize domestic resources, is projected to result in the importation of 40 percent more oil by 2030 than today with a corresponding negative impact on the nation's foreign trade balance and an untenable threat to national competitiveness and security. Under these conditions, domestic oil replacement resources based on coal-derived synthetic fuels, can phase down oil imports, and ease the transition from direct internal combustion powered vehicles to electrified urban personal and public transportation.

This conversion to domestic resources is encouraged by the linkage among trends which appear likely to reach their climax as we enter the new century. First, the probability that oil prices will rise rapidly as demand exceeds proven reserves and Middle East "preferred" production capacity is exceeded, even under politically stable regional conditions. Second, political pressure in the urban centers of the U.S., Europe, and Japan to phase out internal combustion-powered vehicles. Third, the escalating negative impact of imported oil dependence on economic competitiveness and the resulting untenable political stresses created among the U.S., Europe, and Japan.

The coincidence of such climactic trends, all driven by scarce resources, has historically forced economic crises triggering rapid political reaction. Fortunately, among the three major Western economic blocks, the U.S. has the advantage in being able to phase out its imported oil dependence in favor of indigenous resources. This is likely to be an exceptionally important international business advantage while protecting political cooperation from the stress of competition for dwindling resources. As a result, U.S. coal may prove to be as important to protecting the Western alliance during the next 50 years as the U.S. military umbrella has been during the past 50 years.

This goal is most likely to be achieved through integrated processing facilities capable of translating coal and other carbonaceous material into a variety of products including, but not limited to, electricity. Power production from these facilities will be one product of a broader resource processing capability that can also competitively produce transport fuel and chemical feedstocks, and recover marketable mineral credits (11). The economic importance of such a co-production approach is underscored by its potential to reduce electricity generating costs by 25% or more. Controlling the commercial high ground in this coal-based energy revolution will likely be one of the most important economic determinants facing the coal and power industries, and this nation, over the next 20 years.

The state-of-the-art in this coal refining technology is reflected by the commitment of the SEP electric utility in the Netherlands to build a 2000 ton/day, coal gasification combined cycle power plant generating 250MW of electricity for startup in 1993. Similar projects are also under consideration for the 1990s here in the U.S., if public perceptions and policies do not contradict their timely implementation.

Coal gasification will be the core technology for this transitional strategy, which will lead to clean, high efficiency, coal fired plants. Advanced devices, such as high temperature gas turbines and molten carbonate fuel cells, convert the chemical energy in fuels to electricity more efficiently than boilers. They do, however, require clean fuels for effective operation. Since coal gasification creates a fuel gas which can be cleansed of pollutants without the formation of waste products, it can be coupled with the very efficient energy conversion devices noted above (12). It is thus possible to reduce the amount of coal required to produce a unit of electricity, relative to a coal fired boiler with back end emission controls (scrubbers and selective catalytic reactors), by 1/6 with Integrated Gasification Combined Cycle technology and by 1/3 with Integrated Gasification Molten Carbonate Fuel Cell technology.

In short, the result of this technological transformation will be an integrated energy and resource production foundation based on indigenous fuel which can serve not only as a transition energy capability for the U.S. and other developed nations but a fundamental economic base for the less-developed world as well. The mortar that cements, or integrates, these coal utilization building blocks and makes them an operationally practical reality is the same microprocessor revolution which is now being technically and culturally assimilated to enhance the productivity of existing power plants. This "smart" instrumentation would enable knowledge-based diagnostic and control systems to manage plant operations as well as robotic systems to perform maintenance and inspection.

The national goals for this progress require little vision. They are:

- providing at least 200 GW of new electrical generating capacity;
- replacing 10 million barrels per day (MBD) of oil imports.

Achievement of these goals by 2010 is not simply desirable but appears essential to our national economy, security and environment.

The policy steps needed to accomplish these goals are incentives to (a) immediately phase down oil imports in favor of domestic sources, and (b) reduce pollutant formation through the harnessing of real technological innovation to domestic energy production.

The direct commercial benefits to the nation through lower cost electricity, increased power equipment exports, and reduced oil imports alone are expected to escalate, over the next 20 years, to at least $150 billion per year or six times the required $25 billion per year investment. To this should be added the broad fabric of economic benefits resulting from a more competitive economic posture in the world market. Within the required investment, less than one percent would be necessary to complete development of the already well-defined technology base.

As attractive as this opportunity seems, its initial payback period is simply too long and too subject to political manipulation to attract investment under current short-term profit oriented, risk-averse, national policies. As pointed out repeatedly through this paper, these policies, and the perceptions on which they are based, must be changed if this inevitable technological transition is to occur with the greatest commercial and environmental benefit to this nation.

We have unparalleled means to continue to prosper as a nation while being the global leader in productive resource stewardship. The issue remaining is whether, also as a nation, we have the patience and proactive will to invest in this sustainable future or simply continue short-sighted expediencies. The bottom line is whether we care enough to guide our own destiny or leave it to others by default.

NATIONAL ENERGY IMPLICATIONS

Fundamental to addressing the energy challenge is a more proactive American response to global competition among what are now relatively equal economic competitors. In evaluating this pre-eminent national issue, the conclusion is the same as Pogo's - "we have met the enemy and he is us". The greatest threat to our competitive position is not foreign but our own national preoccupation with short-term, risk-averse, policies relative to our more strategic and globally oriented competition. This attitude, encouraged by the perception that post-war U.S. global economic advantage could be taken for granted, is a luxury which the U.S. can no longer afford if we are to sustain national economic and ecological prosperity into the next century.

This transformation will depend on three factors: First, recognition that the unprecedented advances in health, safety and longevity have been the result of the wealth created by our society's entrepreneurial system and its ability to capitalize on technological innovation. History shows that our current preoccupation with no trial without prior guarantee against error is a sure prescription for national voyage into harm's way, both environmentally and economically. The second factor is a change in public perception to one that mandates the same sustained commitment to the unmatched U.S. "soft" power advantage in resources and technology that has marked our military leadership over the past 50 years. Third, this commitment must be reinforced by public policies recognizing that national economic and environmental security are as dependent on industrial technology as military strength.

This may prove to be be a crucial test of the U.S. Constitutional system's ability to produce sustained and coordinated action dealing with long-term problems in a global society where urbanization and economic differentiation are increasing. If we are successful, however, this transformation can be both the foundation for rebuilding America, and the arsenal of electricity-based energy innovation powering the new century.

This requirement seems particularly germane to the inter-connected agenda driving the Secretary of Energy's National Energy Strategy initiative. This agenda focuses on: electricity reserve margins, environmental pressures on coal, the future of nuclear power and oil imports. The strategic element linking these agenda items is electricity and the technology for its global development. Official U.S. energy policy, however, has historically remained a political creature reflecting popular perceptions of the moment. It has been made up of numerous narrow policies intended to stimulate specific actions for explicit goals, usually established in differing times and circumstances. Thus, it is not surprising that these independent policies are often in conflict and unable to maintain a progressive balance among the numerous competing interests. Achieving such a balance would require a 30-year or longer perspective and, to date, a politically unrewarding concern for the energy structure available to future generations. For example, only immediately after the oil supply interruptions of 1973 and 1978 was there sufficient, but temporary, popular perception of the precarious nature of our dependence on foreign fuel sources to encourage even a fleeting policy glimpse of oil supply reality.

The one enduring factor overlying U.S. energy policy has been the pressure to eliminate environmental side-effects and risks associated with energy systems. Unfortunately, against the false perception of unconstrained energy security and unaffected economic competitiveness, the policy response to environmental risk minimization has focused on short-range clean-up expediencies. This is contrary to achieving a sustainable national, let alone global, balance between energy use and the environment which depends on preventing pollutant formation. The result has been ever larger energy and environmental stresses plus diminished economic competitiveness.

It is therefore disappointing that the National Energy Strategy's appropriately aggressive proposals to reestablish nuclear power are not matched by an equally aggressive vision for our other domestic energy sources, particularly coal. The result, as indelibly outlined by that same strategy, will be increased oil imports, relatively inefficient use of our primary energy resource - coal - and little progress toward a post-carbon energy economy necessary for a sustainable global energy future.

The more we study the major energy problems of our time, the more we come to realize that they cannot be understood, let alone solved, in isolation. They are systemic problems - interconnected and interdependent; and their solution suffers from a "crisis of perception" reinforced by short range policy expediencies. Science has shown that a holistic view -- seeing the world as an integrated system rather than separate parts -- is essential if we are to sustain progress in environmental protection while developing the resources needed for global economic development. Technology, in turn, is providing the means to achieve that sustainable future if we, in turn, sustain our commitment to innovation.

CONCLUSIONS

1. Innovative Clean Coal Technology provides the means to resolve the conflicts between coal use and the environment while protecting U.S. competitiveness in the global marketplace. This is particularly important because of the probability that coal will surpass petroleum as the world's primary energy source by early in the 21st century.

2. The U.S. is not likely to play a major role in this $80 billion per year technology market unless our short-term oriented, risk-averse national investment, trade, technology and environmental policies are changed to encourage a national arsenal of energy innovation. Success will depend on (a) transforming technological advancements - wherever they may be discovered around the world - into high-quality U.S. products and (b) trade policies which reinforce U.S. competitiveness by encouraging strategic investment opportunities.

3. Sustained competitiveness through innovation will require a better linkage of government and private R&D to the productivity of commercial products; strengthening the manufacturing base; the establishment of, and commitment to, higher technical quality standards; investment in the technological training of workers; and better education for all citizens. Policies will have to be altered to encourage sustained, long-term investment in improved skills and facilities necessary to advance the creation, production and use of technology.

4. These national energy related policies should encourage a sustainable balance between energy use, economic competitiveness, and the environment. This will require a change in public perception to one that mandates the same sustained national commitment to creating U.S. "soft power" advantages in coal and technology similar to the unmatched accomplishments that have marked our military power leadership over the past 50 years. National security can no longer be viewed exclusively in military terms.

5. The U.S. has the unique advantage in being able to phase out its imported oil dependence in favor of indigenous resources. This is likely to be an exceptionally important international business advantage while protecting political cooperation from the stress of competition for dwindling resources. As a result, U.S. coal may prove to be as important to protecting the Western Alliance during the next 50 years as the U.S. military umbrella has been during the past 50 years.

6. To be successful, energy policies must instill an appreciation among all sectors of the society that a more strategic use of our limited natural and capital resources is imperative if we are to retain global economic leadership. If political impatience on environmental issues is allowed to continue to dominate the policy process, we will waste enormous resources and commercial opportunities while actually increasing environmental risk. Our choice is clear: continue to focus on "retro" cleanup, which moves the environmental impact around while reducing national productivity, or encourage innovative technology, which eliminates pollutant formation and improves national productivity.

7. As the focus of public perception moves to the global stage, and after-the-fact cleanup becomes increasingly unsupportable, harnessing energy efficiency improvement to prevent pollution becomes essential as the only practical means to address the interactive, global, core resource issues. The central policy theme will be how to balance the world's expanding population and resource aspirations against a finite resource base, including the environment.

8. A refining approach to coal utilization based on coal gasification to produce a variety of products, including at least 50 percent higher efficiency electricity, provides both much higher energy productivity as well as enhanced energy security and global competitiveness. This will be the basis for the world class fossil power plant capable of best addressing the interdependent economic and environmental challenges of a sustainable energy future. It is the essential technological building block for an energy strategy addressing the realities of the coming decades.

9. Fortunately, the U.S. remains a technological and commercial leader for the gas-turbine, fuel cell, coal conversion, and silicon microprocessor technologies essential to this least cost refinery approach to power production and a coal-based national energy economy. The issue remaining is not technological but the national patience and focused, proactive, will to encourage this domestically sustainable energy future.

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Senator **Ford** [presiding]. Thank you, Mr. Yeager.

Mr. LaHaye.

STATEMENT OF PAUL G. LaHAYE, PRESIDENT, HAGUE INTERNATIONAL

Mr. **LaHaye**. Thank you, Mr. Chairman and Members of the committee.

I am feeling a little bit ill at ease and somewhat out of place. I have a specific recommendation regarding the conversion of coal efficiently and environmentally.

Senator **Ford**. Do not feel out of place. We need all of the advice and counsel we can get.

Mr. **LaHaye**. I come from a small organization that has 30 people, and have been dedicated for 20 years to coming up with a way of using coal most efficiently, which happens to fit the period, so it is fortunate that we started 20 years. But given the small number of people involved, I suppose it took us longer than necessary.

It is a little bit like looking up from the bottom, the two things the country has which have been mentioned several times this afternoon are an abundance of coal, and secondly, as Mr. Yeager has indicated, we have a world leadership in gas turbines.

Gas turbine engines use, in combination with steam turbines, called combined cycles, can convert the energy of a fuel to electric power more efficiently and economically than any other means available to us at the present and probably in the near term.

We have talked about a variety of other conversion means, MHD, things of this nature, but they are not going to happen quickly enough to do us a great deal of good before the end of the century.

As all of you know, fuel is normally burned in the gas turbine directly. Thus, relatively clean, ash-free fuel such as natural gas or distillate oil must be used in these machines.

It is not possible to burn an ash-bearing fuel such as coal directly in a gas turbine, because the chemicals in the ash will attack the sensitive high temperature parts of the machine.

Therefore, at present, in addition to being an environmental orphan, coal cannot be used in the most modern, most efficient power plants which are based on gas turbines. As a consequence, coal is at an economic disadvantage.

The U.S. Department of Energy, organizations such as Texaco, General Electric Company, Electric Power Research Institute and others, have tried to emulate oil and natural gas efficiency and versatility by processing the coal before they use it.

Or stated in another way, by putting the coal through a refining process to remove the harmful impurities, the refined coal or the coal derivative could then be burned directly in the gas turbine. In this configuration, the gas turbine is called a direct-fire gas turbine.

In essence, this approach consists of building a mini-coal refinery or coal gasification process, alongside the gas turbine to provide the gas turbine with acceptable fuel. Thus far, this approach has met with limited success.

There are several reasons for this limited success. First, the coal refining process must remove virtually all of a class of impurity found in the coal called alkali oxides, down to approximately 40 parts per billion, for the coal to be acceptable for direct firing in a modern high performance gas turbine.

Secondly, the refining process and the gasification process are capital intensive processes and impose demands on electric utility organizations, without providing them with acceptable incentives.

Thirdly, the coal refining process results in energy penalties, losses that eliminate a substantial portion of the efficiency advantages gained by burning the refined coal in a gas turbine cycle.

There is and there are alternatives. One alternative, which is the one that we have been working on makes coal usable in a gas turbine cycle in its natural form, without the refining processes previously described.

This solution probably dates back to the invention of the gas turbine. It requires the addition of a heat transfer device which we call an air heater to the gas turbine. As previously stated, fuel is normally burned directly in the gas turbines, so that any impurities in the fuel come into intimate contact with the delicate components of the gas turbine.

In the proposed solution, coal would be burned outside the turbine and the energy transferred to the turbine through the air heater. The turbine effectively runs on air.

By so doing, coal and its impurities would not enter the gas turbine. Therefore, it would not be necessary to process the coal to remove the impurities. The coal can be used in a natural occurring state.

In the exterior configuration, only the impurities in the coal that have deleterious environmental affects are removed. The cleaning process is much less complex and much less costly than the cleaning process required to permit burning the coal directly in the turbine.

Also, the efficiency of the cycle is not greatly affected by the coal cleaning process. It is possible, using existing technology to remove the sulfur compounds consistently from the effluent gas.

The ash remaining can be vitrified by the process due to the elevated temperatures used. This vitrified ash will not leach in ground water and may be used safely for a variety of purposes such as road-bed ballast.

The impurities of environmental importance are removed from the coal during and after the combustion process, before the effluent gas is released into the environment. This cleaning process is similar to that currently used by conventional power plants and can remove 95 percent and more of the sulfur. It is a much less complex and costly coal cleaning processing.

This externally fired solution has been considered by a number of investigators since the 1940's, but has been discarded as unworkable because no one could build a suitable air heater. The required operating temperature of the air heater is well above the maximum operating temperature of any readily available metallic materials.

Materials such as ceramics are required and can withstand the chemically aggressive nature of coal ash and the very high temperature. Such ceramics have not been available, but they now can be obtained through a variety of sources in this country.

Which brings into play another industry in the United States that we have a leadership position in, that is the ceramics industry.

We have been developing this air heater for the past two decades. Fundamental to the success of the air heater was the ceramic material evolution. After 15 years of operation and 2 million hours of experience with equipment in Canada and Japan and in this country, we now believe this is a feasible solution.

What does it do for us? It increases the efficiency by approximately 30 percent over the conventional power plant. It can be used to retrofit existing power plants. It can be added to existing power plants easily, readily.

We now have a $4.3 million cooperative agreement with DOE and an externally fired combined cycle (EFCC) consortium of which we are a part. This contract was awarded last February 1990 and we are in the process of building the key device.

At present, the device is going together, we expect to be running it this fall. By the way, we are going to be running it in Kennebunk, Maine. We thought that was an appropriate place, close to Kennebunkport.

Senator **Ford**. Did you say, Kennebar, is that what it is?

Mr. **LaHaye**. Kennebunk.

Senator **Ford**. Maybe on our jogs, you can jog by and it see.

Mr. **LaHaye**. Right. We thought of putting up a sign in front of it, so everyone was aware of this.

So this will provide an alternative source of power, an immediate market for coal, for low and medium grade coal, and would meet the clean air requirements.

The electric utilities which are members of this consortium are particularly interested in the concept because it can be used as a retrofit. It makes the existing plants useful.

Presently, these plants make up approximately 35 percent of the power plant population in the United States. By adding this externally fired gas turbine cycle, we can cut fuel consumption and thereby reduce the emissions from the plant by 30 percent and reduce the cost of running the plant.

I would like to add a footnote to my statement. We have had discussions with over 50 electric utilities in the United States, trying to get them to support this program. Without exception, we have gained the support of their technical staffs, but only in four cases so far have we been able to convince the financial administrative officers of these organizations to participate.

And generally, it boils down to what is in it for us? There is not sufficient incentives for utilities to participate in this kind of a program, which is I think unfortunate.

Thank you, Mr. Chairman.

[The prepared statement of Mr. LaHaye follows:]

Testimony before

United States Senate
Committee on
Energy and Natural Resources

Washington, D.C.
March 19, 1991

Subcommittee on

Energy Research and Development

The Honorable Wendell H. Ford, Chairman

P.G. LaHaye
President
Hague International
3 Adams Street
South Portland, Maine
04106

102d. Congress
S.341

ENHANCING THE USE OF COAL AS A FACTOR IN CREATING THE NATIONAL ENERGY POLICY

It is well recognized that it is in our national interest to continue to increase the use of coal to generate electric power, providing that we can do so in an environmentally acceptable way. In the long-term our reliance on foreign energy supplies from politically unstable areas of the world threatens our national security. Approximately 55% of our electric power is currently generated using coal. Due to the presence of naturally-occurring chemical impurities such as sulfur and nitrogen in the coal, most coal is not an environmentally acceptable source of energy in its natural form. It is necessary to process the coal to remove the harmful elements; or, alternatively, to provide a means of cleaning the effluent streams, after or during the combustion process, i.e before the effluent is released to the environment. Both of these methods of making coal environmentally acceptable are expensive and substantially reduce the competitiveness of this fuel as an energy source.

In addition to having an ample coal supply, we in the United States have been a world leader in the development of high performance gas turbines. Gas turbine engines, used in combination with steam turbines called "combined cycles", can convert the energy in a fuel to electric power more efficiently and economically than other means available to us at present and in the foreseeable future.

Fuel is normally burned directly in gas turbines; thus relatively clean non ash-bearing fuels, such as natural gas or distillate oil, must be used in these machines. It is not possible to economically burn an ash-bearing fuel such as coal directly in a gas turbine because the chemicals in the ash will attack the sensitive high temperature parts of the gas turbine. Therefore, at present, in addition to being an "environmental orphan", coal cannot be used in the most modern, most efficient power plants which are based on gas turbines. As a consequence, coal is at an economic disadvantage.

The U.S. Department of Energy and private sector organizations such as Texaco, General Electric, Electric Power Research Institute (EPRI), and others have tried to emulate oil and natural gas's efficiency and versatility by processing the coal before using it; or stated in another way, by putting the coal through a refining process to remove the harmful impurities. The refined coal or the coal derivative could then be burned directly in the gas turbine. In this configuration the gas turbine is said to be "direct-fired". In essence, this approach consists of building a "mini-coal refinery" or "coal gasification" process alongside the gas turbine to provide the gas turbine with an acceptable fuel. Thus far, this approach has met with limited success. There are several reasons for this limited success. First, the coal refining process must remove virtually all of a class of impurities found in the coal called alkalai oxides, i.e. down to concentrations of 40 parts per billion, for the coal to be acceptable for direct firing in modern high performance gas turbines. Secondly, the refining process and the gasification process are capital intensive processes and impose demands on electric utility organizations without providing them with equitable incentives. Thirdly, the coal refining process results in energy penalties (losses) that eliminate a substantial portion of the efficiency advantages gained by burning the refined coal in a gas turbine based power cycle.

There is an alternate. This alternate is a promising solution that would make coal usable directly in a gas turbine cycle in its natural form, without the refining previously described. This solution probably dates back to the invention of the gas turbine. It requires the addition of a heat transfer device called an "air heater" to the gas turbine. As previously stated, fuel is normally burned directly in the gas turbine, so that any impurities in the fuel come into intimate contact with the delicate components in the gas turbine. In this solution, coal would be burned outside the turbine and the energy transferred to the turbine through the "air heater". By so doing, coal and its impurities would not enter the gas turbine (reference Exhibit A). Therefore, it is not necessary to process the coal to remove the impurities. The coal can be used in its naturally-occurring state. When using the "air heater" the gas turbine is said to be "externally-fired" or "indirectly-fired".

In the "externally-fired" configuration only the impurities in the coal that have deleterious environmental effects are removed. The cleaning process is much less complex and much less costly than the cleaning process required to permit burning the coal directly in the turbine. Also, the efficiency of the cycle is not greatly affected by the fuel cleaning process. It is possible using existing technology to remove 95% of the sulfur compounds consistently in the effluent gas stream. The ash remaining can be vitrified by the process due to the elevated combustion temperatures. The vitrified ash will not leach in ground water and may be used safely for a variety of purposes, such as road-bed ballast. The impurities of environmentally importance are removed from the coal during and after the combustion process, before the effluent gas is released into the environment. This cleaning process is similar to that currently used by conventional power plants. It is a much less complex and costly coal cleaning process than the refining process previously described. In addition this cleaning process does not appreciably compromise the thermal performance of the power plant.

The externally-fired solution has been considered by a number of investigators since the 1940's, but had been discarded as unworkable because no one could build a suitable "air heater". The required operating temperatures of the "air heater" are well above the maximum operating temperature of any readily available metallic materials. Materials such as ceramics are required that can withstand the chemically aggressive nature of coal ash at very high temperatures. Such ceramic materials were not then, but are now, becoming available to build such a device.

In 1973 Hague International introduced the first successful industrial ceramic "air heater", for the steel processing industry. Fundamental to the success of this "air heater" was the use of ceramic materials. After 15 years and over two million hours of operating experience with ceramic air heaters in the U.S., Canada, and Japan, Hague initiated a program in 1988 to demonstrate the feasibility of a gas turbine ceramic air heater. This program was supported by the U.S. Department of Energy, and a consortium of electric utilities and private sector companies. This "air heater" is now under construction and is to be demonstrated in a proof-of-concept test during the Fall of 1991. Hague is conducting this work under the auspices of a U.S. Department Of Energy Morgantown Energy Technology. The work is being performed under a $4.3 million Cooperative Agreement between DOE and the "EFCC Consortium".

The $4.3 million contract was awarded on February 7, 1990 to Hague International to develop a pressurized, coal-fired, ceramic gas turbine "air heater". The $4.3 million Cooperative Agreement is a cost-sharing agreement, wherein $2.3 million is the government share and $2.0 million is being provided by the EFCC Consortium. The Consortium members are listed in Exhibit B. For the record the project is titled "High Pressure Ceramic Air Heater for Gas Turbine Applications", and generally known as the "Externally-Fired Combined Cycle (EFCC) Program" (reference Department of Energy Contract No. DE-FC21-90MC26008).

At present, Hague International is the principal U.S. manufacturer of high-temperature, tubular ceramic heat exchangers. The "proof of concept" development project will be conducted at Hague's facilities in South Portland and Kennebunk, Maine. Following subscale component development tests, the project will culminate in 300 hours of coal-fired demonstration tests of the air heater at a commercial scale.

Success with this demonstration would elevate coal's efficiency to that of oil and natural gas. This will place coal on a more equal footing with oil and natural gas, thereby largely eliminating the current economic disadvantage of coal. The higher conversion efficiency of the air heater would also reduce the environmental consequences of using coal by reducing by approximately one third the amount of coal required to generate a kilowatt hour of electric power. Success with this program would make our abundant and indigenous coal supply a more viable fuel for electric power generation. In the recent past, the rush to natural gas has caused serious concerns over both price and availability of the natural gas supply in the United States. The EFCC provides a competitive alternative for power plants and an immediate market for low to medium grade coals without compromising our environment.

The electric utilities are particularly interested in this concept because it can be used to retrofit and up-grade existing obsolete coal-fired power plants. Presently these plants make up approximately 35% of the power plant population in the United States. The "externally-fired" gas turbine would make such obsolete coal-fired plants competitive and enable the electric utilities to afford the environmental equipment now mandated by the Clean Air Act.

EXHIBIT A

GAS TURBINE CONVERSION TO EXTERNAL FIRING

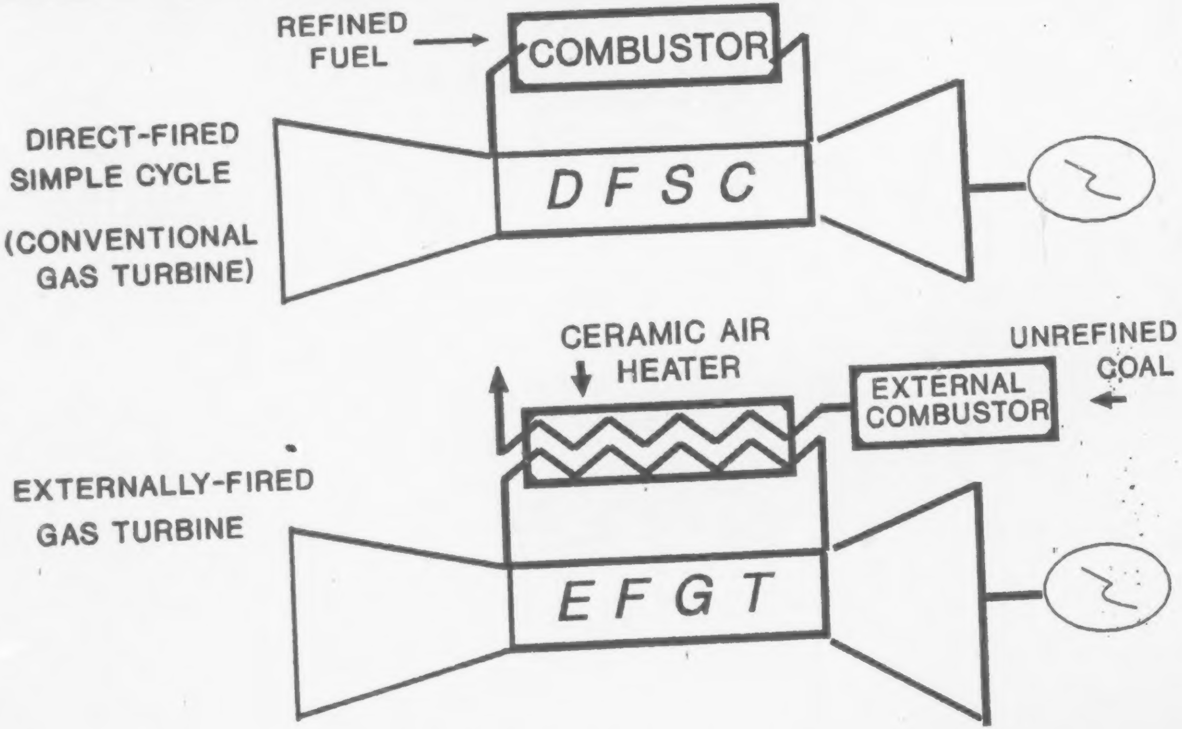

REFINED FUEL
COMBUSTOR
DIRECT-FIRED SIMPLE CYCLE
(CONVENTIONAL GAS TURBINE)
D F S C
CERAMIC AIR HEATER
UNREFINED COAL
EXTERNAL COMBUSTOR
EXTERNALLY-FIRED GAS TURBINE
E F G T

EXHIBIT B
PROPOSED EFCC PHASE IIA CONSORTIUM
2/11/91

1.ELECTRIC UTILITIES

*** 1.1 Allegheny Power Service Corporation[1]
*** 1.2 Brooklyn Union Gas
* 1.3 Consolidated Edison[2]
*** 1.4 Duquesne Light[1]
* 1.5 Florida Power Corporation
* 1.6 New York State Power Authority[2]
*** 1.7 Pennsylvania Electric Company[1]
* 1.8 Southern Company Services
*** 1.9 Union Electric

2. UTILITY ORGANIZATIONS & ASSOCIATIONS

* 2.1 Electric Power Research Institute (EPRI)
* 2.2 Empire State Electric Energy Research Corporation (ESEERCO)
*** 2.3 Pennsylvania Electric Energy Research Council (PEERC)

3. STATE FEDERAL & FOREIGN GOVERNMENT AGENCIES

* 3.1 U.S. Department of Energy (Morgantown Energy Technology Center)
*** 3.2 British Coal Corporation (Coal Research Establishment)
* 3.3 New York State Energy Research Development Authority (NYSERDA)
*** 3.4 Ohio Coal Development Office
*** 3.5 Province of Quebec

4. INDUSTRIAL

* 4.1 Allison Division of General Motors Corporation
*** 4.2 Cogentrix
* 4.3 E.I. Dupont
* 4.4 Foster Wheeler Development Corporation
* 4.5 Hague International
* 4.6 Stone & Webster Engineering Corporation
* 4.7 Union Carbide

5. FUEL SUPPLIERS

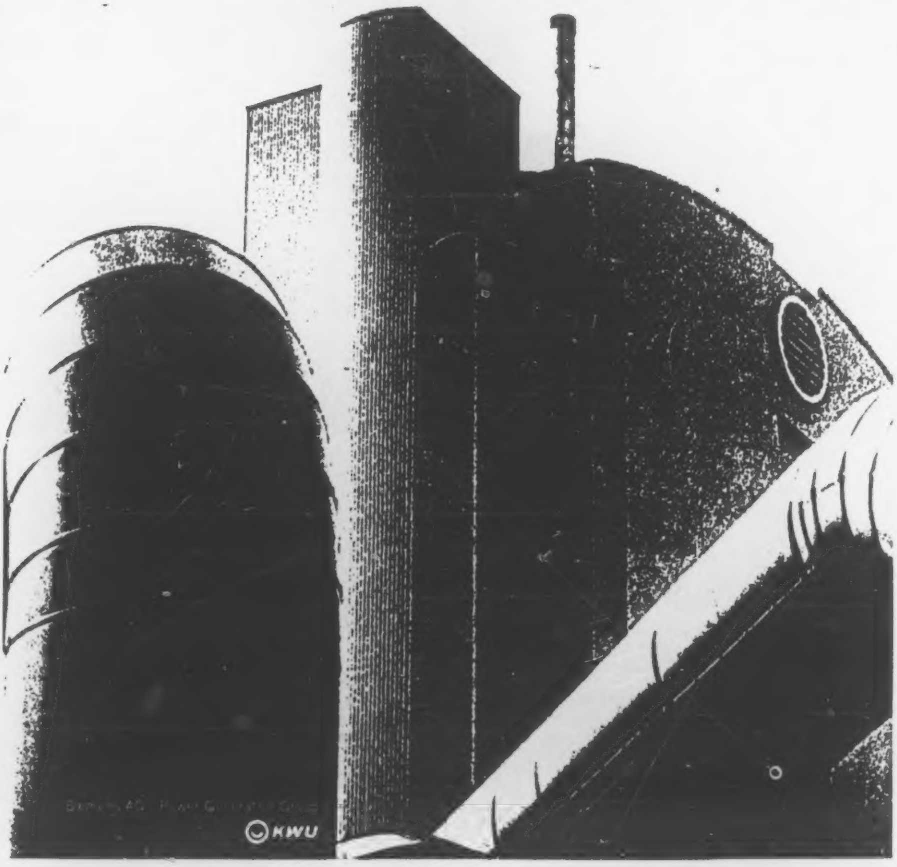
Note: * Single asterisk are organizations with whom we have written agreements, or written agreements in process, as of 2/11/91
** Double asterisk are organizations with whom we have verbal agreement as of 2/11/91.
*** Triple asterisk are organizations that have expressed an interest but with whom we have no agreement.

[1] Commitment through PEERC with other utility members, Allegheny Electric Co-op, Philadelphia Electric, and Pennsylvania Power and Light.

[2] Commitment through ESEERCO, with other utility members Central Hudson Gas & Electric Corporation, New York State Electric & Gas Corp., Niagara Mohawk Power Corp., Orange and Rockland Utilities, Inc., Rochester Gas & Electric Corp.

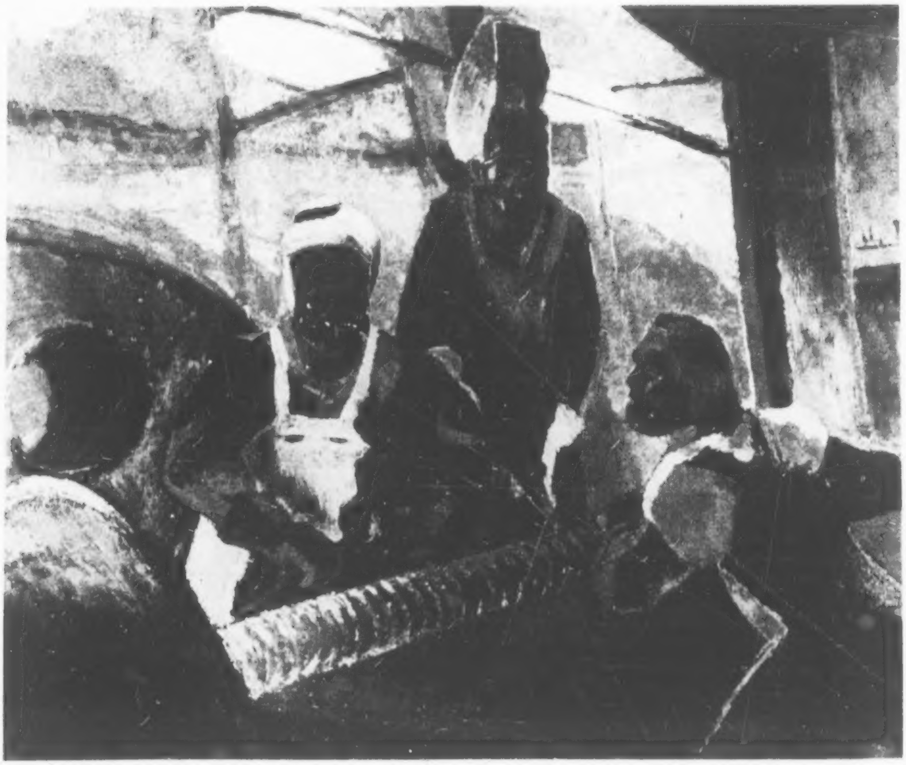
All other organizations have not been contacted, have not responded or have indicated they may join later as of 2/11/91.

POWER GENERATION TECHNOLOGY



THE INTERNATIONAL REVIEW OF PRIMARY POWER PRODUCTION

1990/91



Workmen removing a ceramic heat exchanger tube from a kiln at Hague International

Painting by John J. E. Bjerklie

FORGING THE FUTURE OF WORLD ENERGY.

Ceramic heat exchangers, manufactured by Hague International, will provide industry with highly efficient power cycles that are capable of utilizing a wide variety of ash bearing fuels economically and in an environmentally acceptable manner

HAGUE INTERNATIONAL

3 Adams Street • South Portland, Maine 04106 • USA
Tel. 207 799 7347 • Fax 207 799 6743

Externally fired combined cycle project for solid fuels

Paul G LaHaye
Hague International, USA

An indirect-fired gas turbine demonstration project has been initiated by a consortium of electric utility organisations, industrial organisations, as well as state and federal organisations, which include among others the US Department of Energy, the Electric Power Research Institute, Empire State Electric Energy Research Company, Allison Division of General Motors Corporation and Foster Wheeler Corporation.

The demonstration is to determine the feasibility of applying a high temperature heat exchanger, developed by Hague International of South Portland, Maine, USA, to a gas turbine without compromising the turbine performance. A successful demonstration would make available to the industry a solid fuel power cycle of exceptionally high thermal conversion efficiency which would accept ash-bearing solid fuels such as coal and peat.

In addition to the heat exchanger, Hague is developing a multiple fuel, electric power generation gas turbine cycle (based on the semi-closed cycle configuration shown in Figure 1) intended for electric utility and industrial applications. This energy conversion cycle is intended primarily for the conversion of coal to electric power.

The externally fired cycle development programme consists of a series of proof-of-concept tests, combined with R&D activities, to be followed by the construction, installation, and operation of a prototype. Table 1 summarises the programme phases. Phase 1 was completed in March 1989 and Phase II was begun in February 1990. The R&D comprises several tasks necessary to support the demonstration of a fully optimised and commercially viable electric power generation system.

The key to the externally fired combined cycle concept and the focus of the programme is a ceramic heat exchanger developed specifically for gas turbines.

This heat exchanger would permit the use of a wide variety of ash-bearing fuels. The energy from the combustion process would be transferred through the heat exchanger to the gas turbine; permitting the gas turbine to operate on clean air as the working fluid.

At the request of several electric utilities, the Electric Power Research Institute (EPRI) convened a technical assessment panel of industry experts to assess the concept in 1987. This panel concluded that the concept was sufficiently promising to warrant further evaluation and that a commercial system based on this concept was a valid need of the electric utility

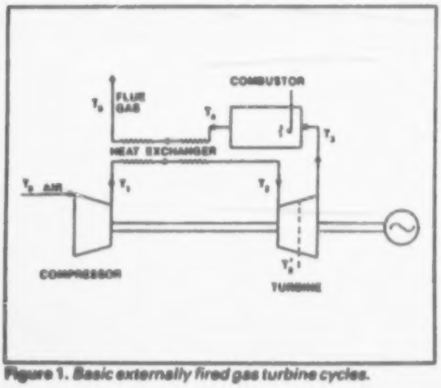


Figure 1. *Basic externally fired gas turbine cycles.*

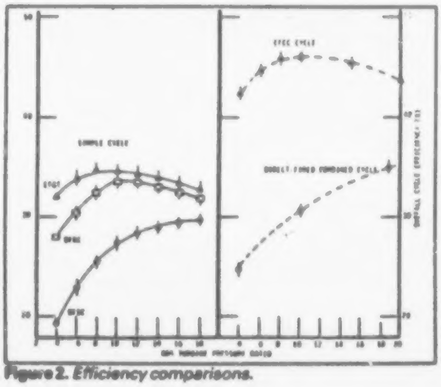


Figure 2. *Efficiency comparisons.*

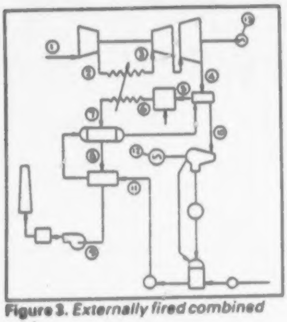


Figure 3. *Externally fired combined cycle.*

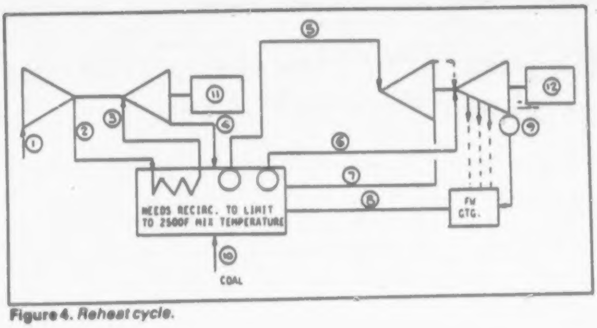


Figure 4. *Reheat cycle.*

industry. The potential advantages of the externally fired combined cycle concept are numerous. It converts fuel to electricity in small unit sizes (50MW) with high efficiency. It operates on a wide variety of ash-bearing fuels, with acceptable atmospheric emissions when coupled with existing ash and sulphur-controlled technologies. It consists of modular subassemblies that can be factory assembled with low initial cost, and short lead time from order to initial operation, with minimum field erection cost.

The concept can be adapted to commercially available gas turbines including aircraft derivatives and can accommodate a variety of turbine improvements such as higher pressure ratios, higher firing temperatures, and steam injection, because the gas turbine operates on a clean working fluid. The concept is particularly desirable for high performance aircraft derivatives. It decouples the thermal input of the gas turbine and the bottoming cycle in combined cycles, permitting the independent adjustment of bottoming-cycle inlet gas temperature to optimise the bottoming cycle performance and is suitable for progressive power generation for better parallel incremental load growth, thereby reducing the financing costs compared with other coal-conversion alternatives. It can be adapted to retrofit existing steam-cycle power plants matching existing steam conditions exactly, with dramatic increases in output and improvements in thermal efficiency; and it has a comparatively low first cost.

The atmospheric-pressure ceramic heat exchanger is currently marketed under the trade name of CerHx in Japan under licence. The heat exchanger combined with a suitable atmospheric pulverised coal combustor would replace the combustion system with the conventional open-cycle gas turbine. The heat exchanger accepts air from the gas turbine compressor at discharge conditions, heats this air to a slightly higher temperature than that required for the turbine inlet, and returns the air to the turbine section for expansion. The clean air delivered to the turbine replaces the products of combustion in the conventional open cycle. This feature is expected to extend the service life of the turbine section. Only the static ceramic tubes in the heat exchanger are exposed to the high-temperature corrosive effects of the impurities in the fuel.

The tubular heat exchanger has undergone a number of design refinements and tube material improvements over the last decade. During this period the heat exchanger has been operated in excess of two million hours under various high-temperature environments in the aluminium and steel industries and more recently, in hazardous waste incineration applications. Hague has accumulated several thousand hours of operation with ash bearing fuels, and has approximately 500 hours of operation on the products of coal combustion entering heat exchangers at temperatures of up to 1535°C.

In collaboration with the British Government and Ruston Gas Tur-

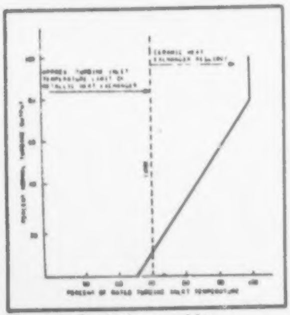


Figure 5. *Typical gas turbine performance curve.*

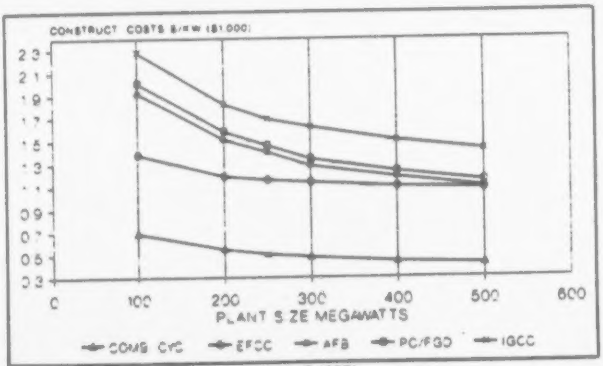


Figure 6. *Fossil power plant costs (base $ 1985).*

Phase I	Low-pressure CerHx tube ash deposition and screening tests (completed)
Phase IA	Verification of heat exchanger protection system
Phase II	Prototype CerHx exchanger pressure integrity and fuel compatibility verification (1MW). Abbreviated title: "Integrated test"
Phase III	Prototype externally fired gas turbine (5–10MW). Abbreviated title: "Prototype"
Phase IV	Commercial externally fired combined cycle demonstration (60–100MW). Abbreviated title: "Demo"

Table 1. *Summary of externally fired combined cycle programme.*

bine, the company has also built and tested pressurised tube-string elements of a heat exchanger. The purpose of the pressurised tests was to establish the feasibility of attaining gas turbine pressure levels without excessive leakage. To simplify the initial pressure tests, the apparatus was heated electrically so that the heat exchanger elements under pressure and temperature were not exposed to the products of coal combustion. A complete test would require both pressure and exposure to the products of combustion.

During 1988 under Phase I of the externally fired combustion cycle programme, the heat exchanger was exposed to the products of combustion of a coal/water mixture to demonstrate the coal compatibility of the design. The results of the Phase I tests provided the consortium with experimental results that were sufficiently encouraging to proceed with full scale test of a 2MW heat exchanger and combustor.

There are currently two broad categories of power-conversion cycles for ash-bearing fuels that involve gas turbines and that are known to be under consideration by the Department of Energy for the utility industry. These are direct-fired cycles and indirect-fired cycles. Each is divided into a number of sub-categories.

Direct-fired: the direct-fired cycles all require fuel enhancement to reduce certain of the ash components to levels which are acceptable to high performance gas turbines. This is in contrast to the indirect-fired cycle addressed by this project, which can accept fuels of approximately the same quality as steam generators.

A workshop held by EPRI in 1985, to consider direct-fired cycles with conventional pulverised coal, concluded that there would be great difficulty in developing the equipment. Still more negative was the conclusion that even a successfully developed turbine, would not find a niche in the utility industry. It would be high capital cost equipment, yet not burning high-cost fuel since the coal used would have to be extensively upgraded into a very low ash slurry. Thus, it would neither fit base load nor peaking dispatch requirements.

A subset of the direct-fired gas turbine cycle is the integrated gasification combined cycle, which consists of the coal gasification plant combined with a gas/steam turbine plant. Due to the low tolerance of the high performance gas turbine to certain trace amounts of vaporised ash constituents, the product gas burned in the gas turbine either must be cleaned at low temperature or at high temperature to remove the corrosive impurities. The low temperature cleaning process results in the loss of a substantial amount of the thermal energy, thereby degrading the cycle performance. The high temperature cleaning process is still under development, and both the reliability and economics are uncertain at this time.

Indirect-fired: the externally fired, or indirect-fired, gas turbine combined cycle offers the efficiency potential of the direct-fired cycles while eliminating both the difficult technical problems of a direct coal-fired gas turbine combined cycle and the high cost concerns of the integrated gasification combined cycle approach. Maintenance cost is expected to be lower because the gas turbine runs on filtered air, avoiding contact with the corrosive elements in the combustion products and the steam turbine cycle can be optimised, eliminating the need for cascading pressure steam generators and other exotic steam-bottoming equipment. In the smaller sizes (5 to 20MW) the steam bottoming turbine can be eliminated entirely, greatly simplifying the cycle while maintaining heat rates of 32 per cent or higher.

The cycle can accommodate a wide variety of conventional fuel burners and advanced combustors currently available commercially or under development. These include low NOx, high efficiency suspension burners, fluid beds, pyrolyers and slagging combustor (to minimise the ash-loading on the heat exchanger). The externally-fired gas turbine cycle is a very old concept and is one of the many variations of the Brayton cycle which have been proposed for the conversion of thermal energy to electric power.

In the externally-fired gas turbine cycle, atmospheric air enters the gas turbine compressor and is pressurised and delivered to a high-temperature heat exchanger. Heat energy from the combustion process is absorbed by the working fluid (air) in the ceramic tubes, raising the air to turbine inlet temperatures of 1065°C to 1288°C. The working fluid is expanded through the turbine, provided power is routed to the external combustion, giving low-pressure, high-temperature combustion air to burn the ash-bearing fuel. Sulphur is removed by sorbent injection, NOx is minimised by recirculation and staging. The hot combustion products from the combustor pass over the exterior surface of the heat exchanger tubes, transferring energy through the tube walls to the high-pressure working fluid within the tubes.

With the addition of a bottoming cycle such as a steam turbine, the externally-fired gas turbine becomes an externally-fired combined cycle. The combustion flue gas from the ceramic heat exchanger may be passed through a heat-recovery boiler to generate either steam for process use or additional electric power. The combustion products then pass through pollution abatement equipment, as may be necessary, and exit to the atmosphere. It is important to

Design Alternative	250MW-Estimated Full-load Heat Rate (Btu (kWH))
Integrated gasification combined cycle	9950*
Atmospheric fluidised bed	975[illegible] *
Pulverised coal/FGD	98[illegible]*
Externally fired combined cycle	8000[illegible]*

* From EPRI Technical Assessment Guide
** Consistent with Technical Assessment Guide

Table 2. *Estimated full-load heat rates for coal-fuel alternatives.*

note that the temperature of the gas exiting the ceramic heat exchanger can be selected to optimise the bottoming cycle by simply selecting the appropriate heat-exchanger effectiveness. Figure 2 shows a comparison of the externally fired gas turbine to simple and regenerative-cycle gas turbines at a turbine inlet temperature of 1150°C. It should be noted also that the cycle efficiencies are taken from the *coal pile* to the generator terminal and are based on the higher heating value of the fuel. Both the direct-fired simple cycle and regenerative cycles gas turbines reflect a 20 per cent efficiency reduction, or penalty, to account for the coal gasification and cleaning process.

Figure 2 also shows a comparison of direct- and indirect-fired gas turbines with and without bottoming cycles. For electric utility applications the combined cycle is expected to be the dominant configuration of the concept.

The fuel flexibility, high efficiency, and simplicity of the externally fired combined cycle are its principal attributes. Commercially available gas turbines can be employed with relatively minor modifications to accommodate the heat exchanger in place of the gas turbine combustion systems. This has been confirmed by preliminary work by General Electric Company on its 6001 Series Turbines and the design and construction of a prototype gas turbine by the Allison Division of General Motors Corporation. A variety of combustion systems can be used for the externally fired combined cycle. To obtain the higher thermal conversion efficiencies consistent with accepted industry practices and sound economic judgment, the following additions to the basic format have been considered:

- Steam reheating, which leads to higher top steam cycle pressure, that is, 1450lb/in^2 and above, using the gas turbine exhaust flow ahead of the combustor for an energy source
- Lower gas turbine pressure ratios to obtain a better match with the bottoming cycle
- Stack gas recirculation to use all the cycle air for combustion, thereby lowering the specified installed cost of the power plant and reducing NOx emissions
- A superheater in the gas turbine exhaust in place of a steam cycle reheater, to lower the specific installed cost and to reduce the combustion air preheat to the combustor, and
- Steam and water injection to increase mass flow.

Figure 3 shows a non-reheat bottoming cycle with a steam superheater in the gas turbine exhaust. Figure 4 shows a reheat cycle with three extraction heater stages. A preliminary evaluation of the cycle with reheat indicates that an overall percentage thermal efficiency in the mid-40s is attainable with existing hardware excluding the ceramic heat exchanger, that is, heat rates of 7500Btu/kWh (7912kJ/kWh), higher heating value.

The externally fired combined cycle is well suited to the use of a variety of steam-bottoming cycles. It permits the optimisation of the gas temperature entering the waste heater boiler in the bottoming portion of the cycle without the need for supplementary firing. Only one combustion system is needed.

The concept was examined during the 1960s as gas turbine technology advanced. However, the missing element and the only major new component required was a high-temperature heat exchanger, capable of achieving rated gas turbine efficiencies requires turbine first-stage nozzle inlet temperatures approaching 1260°C for contemporary gas turbines. To accomplish this, the heat-exchanger hot gas inlet temperature must be higher than metal tube technology is currently capable of providing. Figure 5 presents a typical gas turbine performance curve and demonstrates what would be achievable with a metallic heat exchanger in an externally fired combined cycle. Due to the limitations on operating temperature imposed by metallic heat exchangers, the turbine power output would be severely reduced.

Logistical problems

The temperature deficiency of the metallic heat exchanger could be corrected by supplemental firing of a clean fuel (for example, natural gas or No 2 fuel oil) directly in the turbine working fluid. However, supplemental firing would adversely affect the economic viability of the concept and present logistical problems where natural gas or refined fuels are not readily available. A ceramic heat exchanger, capable of operating at 1240°C to 1427°C in a corrosive, erosive, and ash-laden environment, is essential if the externally fired combined cycle is to optimise fully the thermal efficiency and capacity potential of the concept with gas turbines, that is, a first-stage turbine inlet temperature of 1260°C and above.

A comparison of thermal energy conversion performance of the gas turbine-based system versus cycle pressure ratio is given in Figure 2. A comparison is shown for the direct-fired simple cycle, direct-fired regenerative cycle, and the indirect-fired cycle. The principal advantage of the latter cycle is that it does not incur the energy loss in preparing the fuel for direct-firing in the gas turbine (taking as 20 per cent in Figure 2). Also, in the combined-cycle configuration, the indirect-fired gas turbine has the benefit of a decoupled bottoming cycle, that is, the gas temperature entering the heat-recovery steam generator can be chosen to yield optimal efficiency and, if desired, to match an existing steam cycle, facilitating a retrofit of an existing steam plant.

More flexibility

From the combined-cycle perspective, the most significant change that occurs when the cycle is indirectly fired is that the bottoming cycle no longer depends on the temperature levels of the gas turbine exhaust. This provides a new degree of thermal flexibility which permits thermal optimisation of the bottoming cycle without requiring multiple pressure levels, multiple combustion systems, mixed working fluids, and so on. This is an important consideration when *topping* an existing team power plant. For example, it is possible to use existing high-performance tandem or cross-compound steam turbines rated 3500lb/in^2 565/537°C reheat steam. The externally fired combined cycle can thus be readily adapted for existing high-performance steam plants, increasing output and simultaneously improving the thermal performance of the plant.

A number of cycles have been evaluated based on the externally fired concept such as:

- Bloomfield cycle, with a superheater in the gas turbine exhaust and the "fully fired Bloomfield" with a superheater in both the turbine exhaust and in the ceramic heat exchanger exhaust
- The Turbo Steam cycle, with the steam turbine exhaust injected into the heat exchanger inlet to increase the mass flow of the gas turbine
- The Reheat cycle, described earlier and shown in Figure 4, and
- The Steam Injected cycle.

In general, anything that will improve a bottoming cycle will also improve the overall externally fired combined cycle. Therefore, advantage can be taken of the improvement generated by the ongoing activities with natural gas-fired combined cycles.

Costs

Fuel costs for coal-fuel alternatives vary with heat rate or cycle efficiency, assuming the coal price and characteristics are identical for each design. Table 2 itemises the estimated full-load heat rates for the coal-fuel alternatives. The externally fired technology has a 10–20 per cent lower estimated heat rate than the other coal-fuel alternatives. More recent efforts, using optimised externally fired combined cycle, have shown full-load heat rate projections as low as 7500Btu/kWh, which could further reduce fuel costs.

A preliminary assessment of the economics was performed prior to initiating Phase I of the development programme. Simplified estimates of construction costs were prepared for a nominal 50MW design. A more detailed assessment of capital cost estimates or coal-fired plants was prepared by Stone and Webster Engineering Corporation for a nominal 250MW design, as shown in Table 3.

	IGCC	PC	AFB	EFCC
Total Direct Cost	$314 000	$286 800	$238 600	$201 200
Indirect Costs	31 300	32 500	26 100	24 200
Project Contingency	51 800	47 900	39 700	33 800
Process Contingency	34 500	9600	26 500	31 100
Total Present Day Cost	$431 600	$376 800	$330 900	$290 300
AFUDC*	19 000	16 500	14 600	12 800
Total Plant Investment	$450 000	$393 300	$345 500	$303 100
Dollars/kW	1800	1570	1380	1210

* AFUDC – Allowance for funds used during construction

Table 3. *Capital cost comparison of coal fired plants based on 250MW (1985 constant dollars x 1000).*

	IGCC	PC	AFB	EFCC
Fixed O & M	6.400	6.052	4.945	4.468
Variable O & M	2.743	2.594	2.119	1.915
Consumables	1.300	2.399	3.859	2.002
Fuel	15.175	15.779	15.469	12.922
Total O & M Costs (mils/kwh)	25.618	26.824	26.392	21.307
Per cent Ref PC	95.5	100	98.4	79.4
Per cent Reduction Ref PC	(4.5)	–	(1.6)	(20.6)

Table 4. *Operating and maintenance costs based on 250MW (1985 constant dollars x 1000).*

A further attempt was made to assess the construction costs of this technology versus other technologies, including oil-fired combined cycle, atmospheric fluidised bed, and pulverised coal with scrubber designs. The 1986 *Electric Power Research Institute Technical Assessment Guide* data were used to develop present-day construction costs ($1985) for each technology for 100-500MW designs. Figure 6 shows a comparison of other power-plant types with the externally fired combined cycle technology. A review of the data has shown that the technology, including developmental contingencies, has the potential for significant cost savings versus other coal-fuel alternatives. The lowest cost curve is a gas-fired combined cycle.

Operating and maintenance costs of the technology and three other alternatives were developed in the preliminary assessment of the technology. Consideration was given to fixed costs, and consumables consisting of ceramic tubes, limestone, makeup water, liquid wastes, ash and slag disposal, sludge disposal, and sulphur scale. The results of this analysis are shown in Table 4. The externally fired technology non-fuel operating and maintenance costs are estimated to be 20–30 per cent lower than the other alternatives.

Based on the results to date, externally fired combined cycle technology represents a viable coal-fuel generation alternative with the potential of lower construction, operating and maintenance, and fuels costs for power generators. The concept is an alternative to other coal-based combined-cycle systems under development, primarily because of its flexible design and suitability for both large- and small-scale plants. □

References
1. LaHaye, P G and Fieldmann, B E, *Externally Fired Gas Turbine Combined Cycle*, paper presented at the conference on coal technology '86, Pittsburgh, PA, 1986
2. Zabolotny, E R and LaHaye, P G *Externally Fired Combined Cycle (EFCC)*, paper presented at 1989 ASME Cogen-Turbo III Conference, Nice, France, 1989

Paul G LaHaye has been associated with prime mover development for a variety of applications such as aircraft, ship and railroad as well as gas and steam turbine for power generation. During a professional career, spanning four decades, Mr LaHaye has been associated with the American Locomotive Company in international sales and with the General Electric Company in a variety of functions at the division, staff, and department general manager level. In 1971 Mr LaHaye formed Hague International, and has been Chief Executive since its founding.

Senator Ford. Thank you, Mr. LaHaye.

Let me ask kind of some general questions and it will not take too much longer, but Mr. Katlic testified that projects from round 1 are just becoming commercially viable.

Do the rest of you agree with that, round 1, just becoming commercially viable? Ben, do you have any thoughts on that?

Mr. Yamagata. Mr. Chairman, I am trying to recall those projects in round 1, now under way. There are projects in round 2 as well under way. Of the 33 projects that have negotiated cooperative agreements with the DOE, my recollection is that seven to 10 are up and operating.

Senator Ford. Up and operating.

Mr. Yamagata. Keep in mind that this program has been going for about 4 years now. So that is a pretty good record in terms of the amount of funding that has been negotiated and the variety of projects that have been negotiated.

I would not say at this point that any number of these projects are "commercial." Our definition of commercial is that someone is going to warrant their operability and I am not certain that any are.

I think that Mr. Yeager might be in a better position to inform you on that however.

Senator Ford. Mr. Yeager, could you elaborate on that?

Mr. Yeager. The demonstrations that are underway today are exactly that, to define the commercial viability of the technologies through a joint venture between government and the private sector.

Until those projects are done, I think it would probably be premature to assume that they were all ready to go commercially, it depends on the degree of risk that you want to undertake.

I think it does underscore though, and maybe it is a point that you would like to bring out, and that is, the time frame of doing this kind of work, and that is if you delay these phases you in turn delay the time frame in which the technologies are proven to the point where the private sector can more ahead.

And the whole process of the clean coal initiative was to accelerate that process, not to slow it down. So I would hope that we would keep the wheels turning in this whole process so that technologies, including the one that you just heard about would get their day in court, if you will, for commercial viability.

Senator Ford. Mr. LaHaye, do you have any comment on that statement, about being commercially viable early on?

Mr. LaHaye. I think the only comment I could make is if you wait for everything to be successful before you move on to the next step, we will be here a long time before we can get the full use of some of this technology.

It is a matter of how much risk you want to take.

Mr. Katlic. Mr. Chairman, just a qualification, you need a period of confidence. For these technologies to be at the stage they are at took an enough lot of refining of the merits, the money that is in them from the private sources.

Many States have supplemented the Federal money. You are in a period of gaining confidence with these things now. They are running. They are ready for the next size, and you know, there is a lot of confidence in them, but they need smoothed out.

If these programs do not continue, if these clean coal tech programs do not continue, we will not get the confidence that can take them to the commercial stage, which is not that far away.

I am talking this decade now. My mind is starting to race out and in the years, things do not seem to happen very quickly, do they?

Senator FORD. In the best results, when, if we use that, can we expect these early—say 4 years from now? Do you have a rule of thumb when these technologies might have the confidence that we have just heard, in order to be commercial?

Does it have to be a warranty, Ben? Do I have to say that this is a warranty? I am not sure a utility is willing to take it on if there is not sufficient warranty?

Mr. YAMAGATA. Mr. Chairman, in prior times, and we would be happy to provide this for the record in this hearing as well, we have indicated our own estimate as to when we believe the various technologies in the demonstration program might be commercial available.

[The information follows:]

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1991 MAR 25 AM 10 23

March 22, 1991

The Honorable Wendell H. Ford
United States Senate
Washington, D.C. 20510

Dear Senator Ford:

I would like to take this opportunity to thank the Senate Energy and Research Development Subcommittee for inviting me to testify on behalf of the Clean Coal Technology Coalition at the March 19 hearing on the provisions in the National Security Act of 1991 (S. 341) which affect the use of clean coal technologies.

The Coalition appreciates the continued leadership and support you have shown for the advancement of these promising technologies.

Per your request, I am enclosing a bar chart outlining the expected target dates for the development, deployment and commercialization of various clean coal technologies.

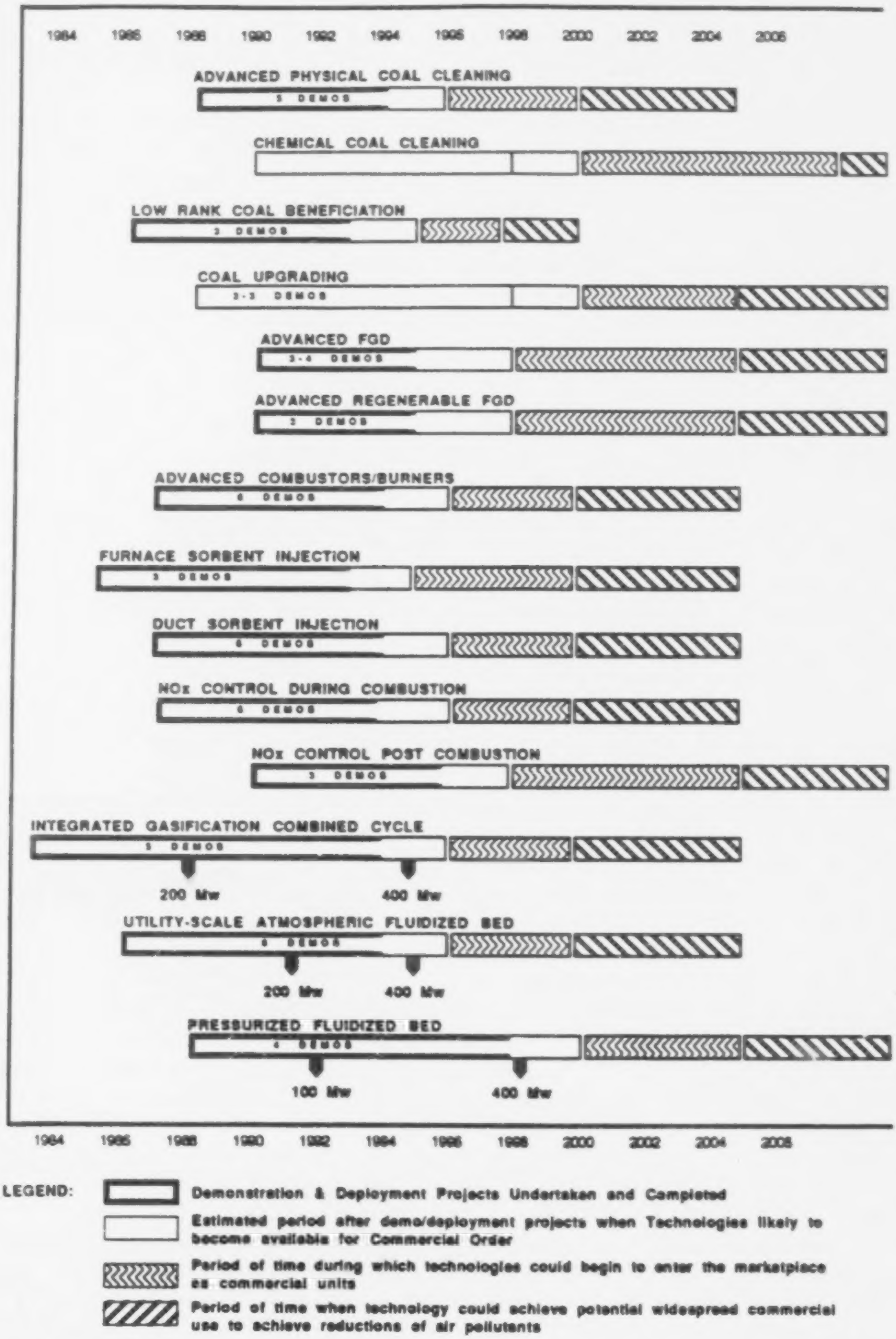
If I can be of any further assistance as the Subcommittee finalizes this important piece of legislation, or you have any questions about the enclosed material, please contact me at (202) 298-1857.

Sincerely,

Ben Yamagata

Enclosure

CLEAN COAL TECHNOLOGY AVAILABILITY



Clean Coal Technology Coalition September, 1989

Mr. YAMAGATA. I would just say that a number of the—what we call the retrofit technologies, I believe our estimate has been in the mid-1990's, that those technologies would be available.

You may recall, as one of the advocates of extension for the phase 2 under the acid rain program, part of our premise for advocating an extension of that phase 2 requirements was so that some of the repowering technologies that are larger and more complicated would also be commercial available in time to assist in meeting phase 2 requirements.

Those types of technologies are likely to be available after the turn of the new century, prior perhaps to the 2004 deadline for phase 2 repowering projects, but certainly in time to meet some of those requirements as well.

So I would say that we are still looking between the mid-1990's to 2005, in that time period, where the current set of technologies under demonstration will be in fact commercially available.

Senator FORD. Mr. Yeager, how much longer will it take to deploy these technologies without Federal support?

Mr. YEAGER. I do not think there is a general answer to that, sir. I think that depends on the technology you are looking at.

Let us take a couple of examples, if I might. One you are particularly familiar with, fluidized bed combustion, and then a clean coal technology that began heavily under private sector work was joined under the clean coal initiative, and is now being deployed through a multiplicity of projects, many of them purely funded in the private sector, as well as some under clean coal, broadly, in both the utility and industrial arena.

So that that one is broadly deployed and in that situation today, because it met a real market niche. There was a lot of market pull on it, as well as technological push.

Some of the other technologies may take longer in that regard. But remember that those projects began about 1980 and here we are in 1990 and we have now turned the corner on those technologies.

For projects that began in the mid-1980's, as most of the clean coal projects did, you are looking at 1995 at best before those technologies are really ready to go.

One of the things that I think it is important to underscore is that commercialization is not an event, it is a process. It is a process that goes through, depending on the technology, a multiple of scales and a multiple of projects.

One of the things that has concerned me in the clean coal initiative has been the debate, well, if we demonstrate a technology once, is that not enough? Typically, it is not enough because as you well know, coal is a highly variable process or material.

The operating conditions are altogether different. So in many cases, we need a multiplicity of projects, and that is not milking the cow as some have characterized it, but a necessary process to develop the confidence by both user and supplier to use it.

The question is, how fast do we want to have it? And I think we are trying to make the case, as everyone else has, that this is such a tremendously important resource, we have to move this technology quickly on a broad front, to have it available to us, and I would target by the turn of the century at the latest, for even our most advanced coal technologies.

Senator **Ford**. Is there any impediment to the speed by which a new process is being developed by the Federal Government participating, or can it move along more smoothly with just straight private funding?

Does anybody have any answer on that?

Mr. **Katlic**. I would like to jump in one moment. I wear several hats. I am part of a utility, the largest coal burning utility, they are playing with clean coal tech, pressurized fluidized bed. We mine coal. We haul coal.

But the coal industry represents, National Coal represents two-thirds of the coal in the United States and as they look at what are the answers to all the diverse groups.

Coal is the simplest looking piece, but the most complicated piece of energy we have. You get into business decisions—I think we were dealt a serious blow on clean coal technology with the passage of the Clean Air Act amendments last year because they are taking resources, there are limited resources, and what private resources have been applied now have to be called into question in order to meet these very serious requirements of phase 1 and phase 2 of the Clean Air Act.

It only points out all the more that some other help has to come to keep the clean coal tech programs going, because from a business decision, the Clean Air Act took a lot of the resources that were being applied to clean coal tech, that had commercial merit or personal merit by each site specific instance, and have diverted them or called the question on them.

Senator **Ford**. Is the money available, is there some bump in the road——

Mr. **Katlic**. I think the answer is obvious, if we had the money we would rather do it ourselves. Just some of these things, just no one company or industry can take them on.

Senator **Ford**. I understand that, but I just wanted to see if maybe there was something could do in public funding.

Mr. LaHaye.

Mr. **LaHaye**. In the private sector in the last 20 years we have developed what is called a combined cycle. We started back in the 1950's with the initial ones, and first we went to Alaska.

It took 20 years for that particular concept to be accepted by most utilities, and there is nothing dramatically different, because we have the steam turbines and the gas turbines, simply put them together.

So I would say that we cannot expect a new technology of any consequence to become a success commercially in less than about 10 years.

Senator **Ford**. Let me ask you something. You say that your project can retrofit and can be added to. Now tell me the difference between the retrofit and the added to.

Mr. **LaHaye**. An existing steam plant, for example, that is burning coal has steam generators and steam turbines.

Senator **Ford**. I understand.

Mr. **LaHaye**. What we do is we take the steam generators out and put in a gas turbine that is coal-fired, externally-fired, and then use a different steam generator and use the rest of the equipment in the plant, all the fuel handling, the steam turbine, the distribution system, the services to the plant, transmission lines, and the siting, which is a big, big effort. You cannot site coal plants easily anymore.

Senator **Ford**. Let me ask you this then, you say you are going to use low and medium grade coal. Have you applied or has your technology applied for any Federal funding?

Mr. **LaHaye**. We are getting help from the Department of Energy. They are providing 55 percent of the funds. The other 45 percent we get from the private sector. We pass the hat so to speak.

Senator **Ford**. I think the average private investment recently has been about 62 percent, has it not, by private operators and the balance by the Federal Government.

Ben, let me ask you something. I noticed in your written statement, I believe on section 5001 in S. 341, are you suggesting that we should undertake additional rounds beyond 5 of clean coal technology demonstration?

Mr. **Yamagata**. Mr. Chairman, I am suggesting that the Secretary, in the requirement to report to the Congress, ought to consider that.

As Mr. Yeager pointed out earlier, you need to consider the development of technologies for purpose of final commercial use as a continuum. There are a number of steps that that technology must go through from the laboratory to the pilot plant, to a demonstration project, to commercial use.

And you will recall in the early 1970's, when the Government was supporting demonstration projects, and it was not until the clean coal program that the Government got back into the business of supporting demonstration projects, which is a vital part of that continuum towards commercialization.

So our suggestion is, yes, we ought to be looking at these new technologies, advanced technologies, and thinking about that continuum of development, and whether or not the Government ought to take a look at a program that is already successful, where the market place is putting in, as you pointed out earlier, 62 cents on each dollar of a project selected.

And maybe there is a good combination there of a private/Federal program that ought to be continued, and at least, the Secretary ought to be required to take a look at that kind of a program and to advise the Congress whether or not we ought to continue that kind of a demonstration program.

Senator **Ford**. Do you have any idea how many more rounds we need, will it feed on itself?

Mr. **Yamagata**. It is possible it could feed on itself. I do not think that the type of funding that we are talking about is a necessary element about that. If you consider the clean coal program we currently have, the Federal Government after five rounds, which is what I hope they end up doing, is going to contribute upwards of $2.5 billion to $2.7 billion.

We had a program at one time where we were simply using demonstrations and the Government was supporting demonstration projects, and we ought to consider doing that same sort of thing with those types of advanced technologies that even the DOE say is very important towards looking towards high efficiency uses or high efficiencies technologies to use coal.

Senator **Ford**. If anybody else has anything, just chime right in.

Mr. **Yeager**. I think there is a dimension that Mr. Katlic brought up which had to do with the Clean Air Act, but I think there is one other dimension here in terms of commercialization that is important.

And that is that the primary user of coal in this country and in the world today is the electric power industry. And the electric industry is a regulated industry, and a regulated industry does not have a risk/profit motive relationship that a typical unregulated industry would do.

The question is, can he really justify to his regulatory commission an investment in risk where that risk has to be balanced between the ratepayer and the stockholder. If the answer is, lay it all on the stockholder, then he cannot undertake that kind of a risk-bearing situation.

So the need here for an industry that is regulated, to have a much lower plateau of risk for the acceptance of new technology is something we have to wrestle with all the time in our Institute, because that is basically why we exist, is to help reduce that.

Senator **Ford**. Mr. Yamagata said, I think your testimony, Ben, that you thought there ought to be some break given, I am not sure I remember all of your testimony, but that they should be given some break at the State government level, and that would be public service commissions or PCU's? Should we be willing to help them in the rate application or something, in order to facilitate these kinds of technologies in order to move forward with them.

Did you say that?

Mr. **Yamagata**. That is the gist of what we were proposing, Senator, that indeed, in the national energy strategy, as I recall, there was a recommendation that the Department of Energy encourage States to come up with regulatory incentives so the utilities would be freer to use clean coal technologies.

Our recommendation, at a minimum, is that the Department of Energy be required to report back to the Congress and to this committee, presumably, on what actions the Department of Energy has taken in order to encourage the States to take such actions.

But indeed, with respect to a regulated entity, the regulatory commissions could probably do a lot to help encourage the use of these technologies.

Senator **Ford**. Anybody else have any comment as it relates to this?

Mr. **Katlic**. Mr. Chairman, DOE has taken a little bit of a hard hit here today because the obvious omissions of the word coal.

I am not trying to defend them, but I do want to say there are some programs that have been working, and if this money is not diverted and these programs keep working, they are very successful clean coal technology programs.

And they have been coming along with good success. So the way it has been working has not been bad. Our chagrin is the fact that it looks like it is going to disappear or the words just do not exist anymore.

I think the clean coal tech program has addressed private interests, State interests. Those projects are in pretty good priority, and I think the success is clear.

So the existing program, its format and the way it has been administered has not been done badly, it is a question that it has to continue——

Senator **Ford**. It is typical Government though. When you have a success, they want to quit.

[Laughter.]

Senator **Ford**. And that is what irks me. Maybe I have been working since 1972. We started back in our State legislature. We funded a lab. We helped with the H process. We paid for coal being transferred from Wyoming, transported from Wyoming, to be put in. Now it is just as cold as Kelsy's right there on the river, and we sit in the Guinness Book of Records everyday, but we quit.

I did not quit. They quit.

Mr. **Katlic**. Senator, in your own State, Island Creek Coal developed a cold water plant, a cold mixture plant that they could take and plug into locals and show them how to do this, and then of course, every time the price of oil changes, these things get mothballed.

If there was a little bit of stability even to the price of oil for a given period of time, we would not be freezing everybody in place, and you could get the merits of these programs——

Senator **Ford**. But see, you just touched a soft spot with me because everything that the Government does and tries to help, it is like ethanol. If corn goes up a little bit and the farmers need corn, they close down the ethanol plant. So it is just like a yo-yo.

You need some stability in there so that the plants can continue to run, we continue to have the ethanol in the gasoline to help clean up the air. We are mandating, you know, ethanol in gasoline in some communities in the Clean Air Act as I recall.

But yet, the poor farmer either has to—the only place he can sell the corn at an ethanol plant at a lower price. If he gets a fairly decent price, looks like he might make some money, then we shut this plant down, and we have to figure out how to do it.

So we put the onus right back on the locals, where they have to pay for it. I am agreeing with you. Ben, yes?

I am getting excited. I am going to have to quit.

Mr. **Yamagata**. Mr. Chairman, I want to underscore what Mr. Katlic has said with respect to the Department of Energy and its administration of the current clean coal program. We think they have done an excellent job with respect to the current program and I want to underscore the point that I also think that they need to continue the program.

Senator **Ford**. Yes, Mr. LaHaye.

Mr. **LaHaye**. I think one of the things that happened with the clean coal program, it ends up, in many cases as being an insurance program against R&D. In the event, for example, that a utility invests 55 percent of the funds required to make a conversion or build a new plant, the first question that comes up is what do we have left if the thing fails?

So the Government picks up 45 percent of the tab and hopefully the answer is that the 45 percent that the Government has picked is all that you are going to scrap. You keep the rest of it and convert back to gas or something else so that they can get their money's worth out of it.

Perhaps what we need is an insurance policy, an R&D insurance policy. But one thing is for certain, we have not got enough failures. If we had more failures, we would be moving faster.

Senator **Ford**. I understand that. We are nickeling and diming to death, in my opinion. We are not saying, this looks excellent—let us get this one out there and see if it really works, and then move on to the next one.

But we want to be even, and the labs out there, you know, the Federal labs, they just want to keep on doing research. As long as they are doing research, they are still in business. They do not want to ever put anything out of the shop into the commercial or to the work place, they just want to keep massaging it.

How do we encourage DOE to reconsider their position and put coal in 100 some odd pages one time and continue this program?

Mr. **Katlic**. I think you are doing it right here. We cannot do it from our side. Congress has to do it.

Senator **Ford**. I just need 50 more votes, Jack.

Mr. **Katlic**. I understand. I think one of you said today, would it be better if this were legislated or if this were left to the system? I have to tell you, when in doubt, I will take Congress because the interpretation of what Congress tells people to do and what they think they should do—and by the time it filters to this group, it looks like a lot different animal.

I would say, in doubt, legislate, and I think the Senate in this bill has the key to making sure this program does not fall through the cracks. It is very important to us.

Mr. **LaHaye**. I think things are going well. I am really impressed with what has been done so far, and I hope Congress will continue pushing more and more on the use of coal.

Mr. **Yeager**. I would underscore that we have spent a lot of time focusing on the R&D aspect and how we promote technology. It is terribly important, but not sufficient. We really need a policy fabric that promotes coal, recognizes its importance, develops the environmental formulas around it in a consistent manner, and also presses for our moving away from imported oil, because as long as we are subject to an energy policy that is changeable by the stroke of a pen in terms of cost, there is really no basis on which that market can pool new technology. So we need that connection.

Mr. **Yamagata**. Mr. Chairman, first of all, with respect to round 5 program, it already is law. The money has already been appropriated. It will require action in the Congress to undo that, notwithstanding the administration's recommendations.

With respect to the title V of S. 341, I would say that a number of suggestions that have been made by the witnesses today ought to be seriously considered for incorporation into your title.

Senator **Ford**. They will be, and once that is done—we would say down in West Kentucky we are going to have to keep our traces tight to pull this wagon.

Thank you all very much. This hearing is adjourned.

[Whereupon, at 4:40 p.m., the hearing was adjourned.]

[The following letter was received for the record:]

WILLIAMS TECHNOLOGIES, INC.
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March 21, 1991

The Honorable Malcolm Wallop
Senate Committee on Energy and Natural Resources
312 Dirksen Senate Office Building
Washington, DC 20510

Dear Senator Wallop:

As Chairman of the Coal & Slurry Technology Association and Executive Vice President of Williams Technologies, Inc., the operator of the Black Mesa Pipeline, I commend you on the introduction of S. 341, the "National Energy Security Act of 1991". I was disappointed, however, that S. 341 did not provide for the federal right of eminent domain for coal pipelines. On behalf of the CSTA Board of Directors, we respectfully urge that you and Chairman J. Bennett Johnston include such a provision as an amendment to S. 341.

Senator Wallop, you have been a supporter of coal pipeline legislation in the Senate for many years; and you, in particular, were responsible for the artfully crafted water language which protects western water rights. Since Wyoming is the largest domestic coal producing state, I hope you will agree how important enactment of coal pipeline legislation is at this time.

At the hearing of March 19th on Subtitle A of Title V of S. 341 before the Subcommittee on Energy Research and Development, two of the distinguished witnesses, William Carr, Chairman of the National Coal Council, and Jack Catlec, Chairman of the National Coal Association, testified enthusiastically in support of coal slurry pipelines. Further, Senator Conrad Burns questioned Secretary Robert Gentile as to why coal pipeline legislation was not included in S. 570, the Administration's energy bill, since support for this legislation was prominently covered in the Administration's National Energy Strategy (NES). Secretary Gentile's response was that he "expected it to be a Congressional initiative". Senator Wallop, that is exactly why a coal pipeline provision is so critical to S. 341, your National Energy Security Bill. Only then can we build on the Administration's support which was reflected in the NES. As you and your colleagues well noted at the hearing, all of the coal provisions of the NES were conspicuously deleted from S. 570, the Administration's bill.

Senator Wallop, we have just concluded a war in the Persian Gulf that emphasizes an unhealthy dependence on foreign oil. Clearly, we have enough coal in this country to satisfy our energy needs for some 400 years. To properly utilize this great natural resource, though, we need economical transportation options like coal pipelines. Compliance with the Clean

Air Act will require utilities to burn substantially greater amounts of low-sulfur coal. Many believe the railroads will capitalize on this by increasing their rates dramatically on these longer hauls. In short, with passage of the Clean Air Act Amendments, the economical transportation of coal by pipeline is more critical today than in past years.

The Coal & Slurry Technology Association is particularly interested in Section 5005 of Title V of S. 341, in which you require the Secretary of Energy to prepare a report on technologies for combining coal with other materials, such as oil or water. In order for these environmentally sound, coal-water mixtures to be fully commercialized, we must be able to transport them through pipelines. By 2010, the U.S. hopes to curb oil imports 40%-45% and reduce oil use by 3.4 million barrels a day. By burning coal-water fuels in power plants and industrial boilers that now burn fuel oil derived from imported petroleum, it is estimated that oil imports would be reduced by 1 to 1-1/2 million barrels a day.

Senator Wallop, we respectfully request that you put coal pipeline eminent domain language into your legislation. This will reflect the support which the Administration gave to coal pipelines in its National Energy Strategy. The coal slurry industry is willing to abide by your stringent state water law protections, but we must remove the artificial legal barriers which block the potential construction of coal pipelines.

Sincerely,

H J Brolick

H. J. Brolick
Executive Vice President

/dc